Volkswagen Lighting

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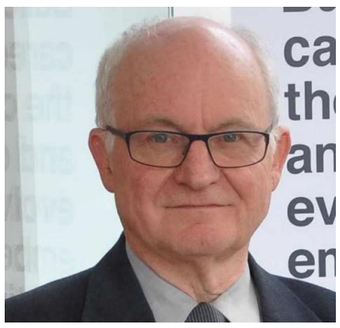
About the author



Jean-Paul Ravier graduated from ISAE SUPAERO (the Institute for Space and Aeronautics Engineering) and IAE Paris (Institute for Administration of Enterprises).

He worked for over 41 years at Valeo, including 29 years at Valeo Lighting where he held a variety of management positions first in IT and finance, and then in R&D, projects, and innovation, including in Japan from 2005 to 2009 at Ichikoh as a board member and managing director. He retired from Valeo in 2013. Shortly thereafter he was appointed chair of the ELS programme (Embedded Lighting Systems) for Advanced Master training and Research in Lighting at the Institut d'Optique Graduate School, ESTACA and Strate School of design. He held that position through the end of 2017 and is now Development Advisor for DVN.

Author's foreword

To build this report, I visited Volkswagen Wolfsburg. I am deeply thankful to Ricardo Plöger, Manager of VW's Lighting and Vision Department and Mathias Thamm in charge of Technology and Innovation developments, and to their teams who took time to show me the lighting organisation, the current very interesting lighting products, and their very promising innovations prepared in the domain of Lighting.
I thank DVN President Hector Fratty for his advice and support, and DVN Chief Editor Daniel Stern for copyediting.

Ricardo Plöger
Manager, Volkswagen AG
Lighting and Vision Department

Executive Summary

Volkswagen are a huge group, one of the first in the world for automotive production, and the Volkswagen brand is both the historic root of the group and the most important of the group's 12 brands.

Like other companies, Volkswagen have seen challenging times, for instance during the redeployment after the monoculture of the emblematic Beetle, and more recently after the diesel emissions compliance issue. But each time, they took the opportunity to re-accelerate. And now after a lot of measures to ensure the best governance and to enhance productivity, the Volkswagen group—and the Volkswagen brand particularly—seem stronger than ever, having kept customer confidence. This is demonstrated by sales that at the group level reached a new record in 2018 at 10.9 million cars, an increase of 1.1% over 2017.

For the Volkswagen brand, a new sales record was set with 6,244,900 cars sold despite the economic uncertainties at the end of 2018, the difficult new homologation process in Europe, and the slowdown in China. This shows the resilience of the Volkswagen brand and the deep attachment from customers to its associated values of quality and strong technical content. VW is one of the most respected brands in the world and considered as a leader for volume production.

Volkswagen's lighting is emblematic of the brand, first symbolised by the original Beetle bearing the best technology possible at a price affordable for a maximum number of people. Lighting at Volkswagen has also a strong technical content. The new technologies are first introduced on higher-range cars, then spread quickly to progressively lower price classes. Volkswagen take care on a case-by-case basis to introduce expensive technologies only when there's obvious added value. That's why laser lighting for high beam range extension was not chosen; this function is now developed with high-performance LEDs at a much more affordable price and is so considered by Volkswagen for all future models.

But despite this attention to costs, Volkswagen's story is peppered with very interesting innovations. Volkswagen had the first BiXenon headlamps (on the 2002 Phaeton), and Volkswagens were first in the world with ADB on the Touareg and Phaeton in 2010. Now, Volkswagen are in the process of democratising the best lighting technologies, so extending for instance the application of full LEDs to all models in Europe, North America, and Asia within the next three years, and extending ADB safety in parallel to all models targeting a take rate of 50% in 2025 (the current 30% figure is already impressive).
Safety and style are the two drivers of innovation in Volkswagen, and we can also observe their application for rear-lighting with the interesting "click-clack" system changing the signature from tail to stop function to reinforce the attention of following drivers—an idea in the process of democratisation to all models.

Volkswagen are now strongly preparing for a future of smarter and smarter lighting and driver assistance systems, and of cars becoming more and more autonomous, electrical and connected. For front lighting, a high-definition digital light using micropixel LED technology with thousands of pixels to optimise the light output for safety and communication is being prepared for application within the next five years. For rear lighting, Volkswagen are developing a matrix LED system to achieve very flexible signatures and communicate with text and signs.

During our DVN visit to VW, we saw a strong lighting team under the management of Ricardo Plöger, a team very motivated and developing with passion very interesting technologies that will certainly help Volkswagen to maintain their pioneering spirit and technical leadership for volume production.

Introduction

There have been DVN profiles on the lighting activities of automakers like Audi, BMW, and Jaguar Land Rover, and a global study for Japanese industry. Now comes the profile for Volkswagen, a maker occupying a huge place in the industry—not only in Germany or Europe, but globally; the VW Group are in constant competition for the title of worldwide leader for volume production, against the Renault-Nissan-Mitsubishi Alliance and Toyota, companies now a bit ahead of the previous leader GM.

In this report, we review the Volkswagen Group's structure and twelve brands. The main target here is to report on lighting in Volkswagen-brand cars, but we can't avoid speaking about the group as a strong global policy links the brands, even as each keeps its own personality.

There have been big changes in 2018 in the Volkswagen AG board with the replacement of CEO Matthias Müller by Dr. Ing. Herbert Diess, keeping also his previous position at the head of the board of the Volkswagen brand, as well as the replacement of five previous board members. Diess is now imposing strong directions to prepare the future, with huge investments—over €30bn—over the next five years to produce more than a million electric cars in 2025 with 50 models. The VW Group are also targeting a clear preparation of connected and autonomous cars and have made several prototypes with a dedicated team. And the problems with diesel emissions seem to have abated.

The Volkswagen brand itself is a legend since the Beetle, and later the Golf. Now the brand has considerably extended its range with twenty-four models from the Up to the Arteon.

In this report, we have chapters on the Group's and the VW brand's main figures and strategy, history, and main models. And we describe the soul of lighting for the Volkswagen brand.

Lighting was always considered as a safety feature, and Volkswagens demonstrate that lately by strong innovations in this domain, for instance the ADB worldwide premiere on the Touareg in 2010. More recently in 2018, the latest generation of Touareg introduced a very performant matrix system with 128 LEDs per headlamp. For rear lamps, their interesting dynamic "Click-Clack" technology changes the lit shape from tail to stop for better attraction of other drivers' attention.

Ricardo Plöger (head of Lighting and Vision), Mathias Thamm, and their passionate team explained to me what they are preparing for the future. With micropixel LEDs up front and matrix rear lamps, for instance, they are clearly putting the future of Volkswagen lighting in a good orbit, with the steady goal to offer the best technologies for safety to the most car owners thanks to the democratisation process they hold dear.

VOLKSWAGEN GROUP

Board Composition

D.ing. Herbert Diess
Chairman of the Board of Management of Volkswagen AG
Chairman of the Board of Management of the Volkswagen brand

Abraham Schot,
Brand Group 'Premium'

Andreas Renschler
Commercial Vehicles

Oliver Blume, Brand Group ‚Sport & Luxury'

Frank Witter
Finance and Controlling

Hiltrud Dorothea Werner
Integrity and Legal Affairs

Dr. Stefan Sommer
Components and Procurement

Gunnar Kilian
Human Resources

Volkswagen Group History

- Volkswagen got started in 1937, to manufacture the car designed by Ferdinand Porsche and known later as the Beetle. 21 million Beetles were produced from 1946 to 2003.

- In 1965 VW acquired Auto Union, which subsequently produced the first postwar Audi models.
- In 1986 VW acquired a controlling stake in SEAT, making it the first non-German VW marque.
- In 1994 VW acquired control of Škoda.
- In 1998 VW acquired Bentley, Lamborghini, and Bugatti.
- In 2008 VW acquired Scania.
- In 2012 VW acquired Ducati, MAN, and Porsche.
- VW have very important operations in China with two main joint ventures: FAW-VW and SAIC-VW. China is now the № 1 market of the Volkswagen group.

The 12 brands of Volkswagen group:

Volkswagen

Audi

SEAT

ŠKODA

BENTLEY

BUGATTI

LAMBORGHINI

PORSCHE

DUCATI

Commercial Vehicles

SCANIA

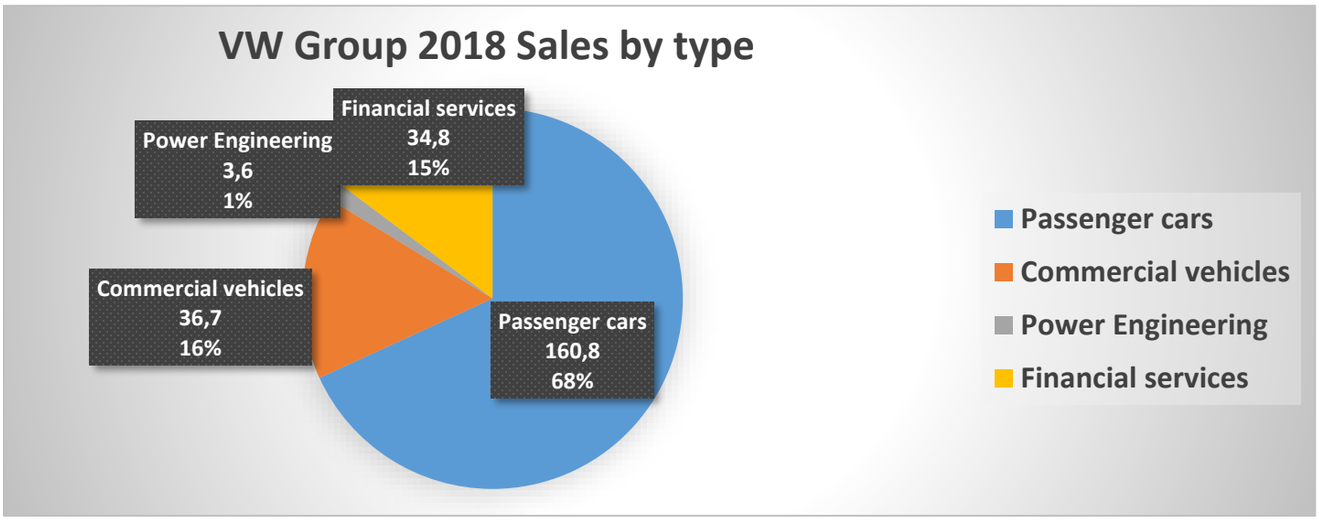
MAN

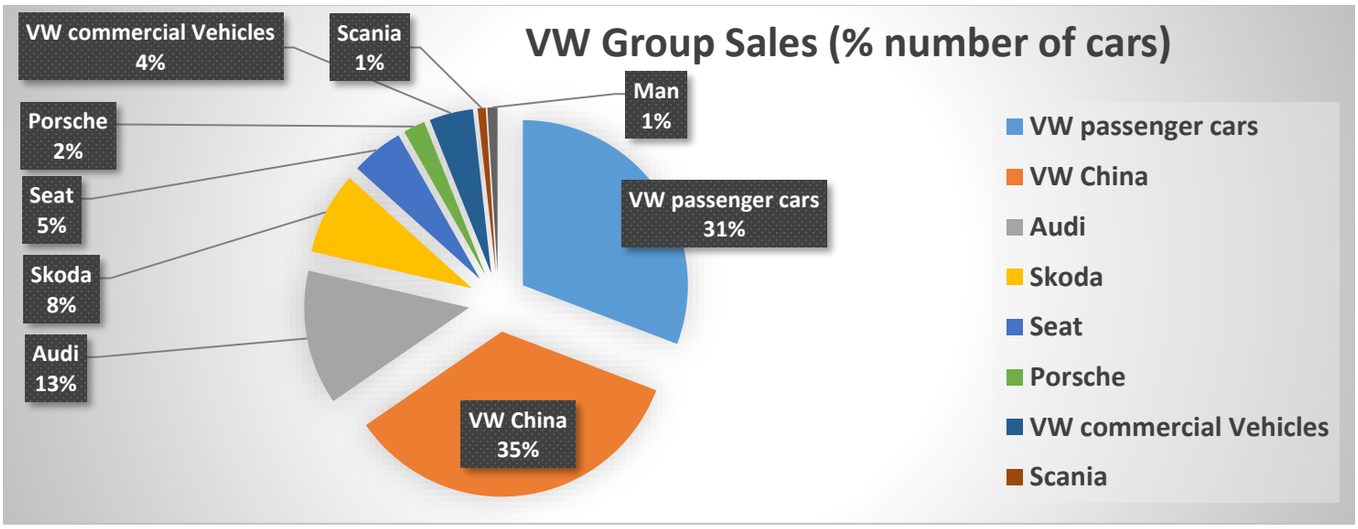
Volkswagen Group Main figures

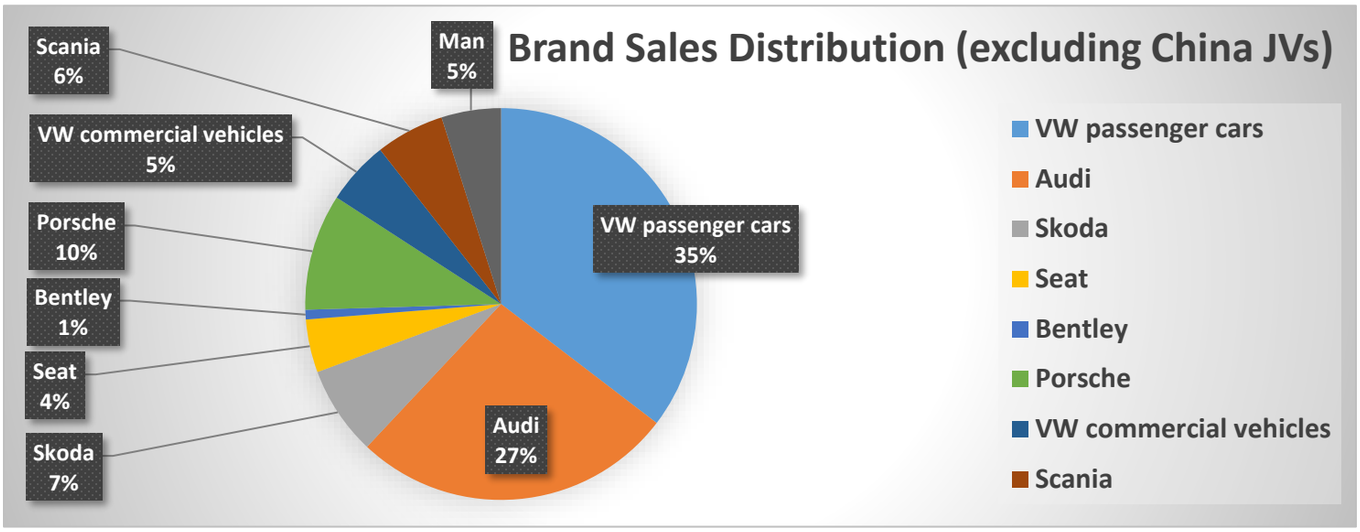
- 10.9 million vehicles sold in 2018 (including JV in China), +1.1% vs 2017.
  VW Group lead the worldwide market with a 2018 market share of 12.1% worldwide (22% in Europe).
- Sales in 2018: €235.8bn, +2.6% vs 2017
- 664,500 employees at end 2018, +3.5% vs 2017
- 123 plants in 20 countries in Europe and 11 in America, Asia, and Africa.
- Operating result 2018: €13.9bn, +0.7%.
- Earnings after tax 2018: €12.1bn +6%
- R&D expenditures 2018 : €13.6bn, +3.8% vs 2017; 6.8% of sales

	VEHICLE SALES		SALES REVENUE		OPERATING RESULT	
Thousand vehicles/€ million	**2018**	2017	**2018**	2017[1]	**2018**	2017
Volkswagen Passenger Cars	3,715	3,573	84,585	79,186	3,239	3,301
Audi	1,467	1,530	59,248	59,789	4,705	5,058
ŠKODA	957	937	17,293	16,559	1,377	1,611
SEAT	608	595	10,202	9,892	254	191
Bentley	10	11	1,548	1,843	–288	55
Porsche Automotive[2]	253	248	23,668	21,674	4,110	4,003
Volkswagen Commercial Vehicles	469	498	11,875	11,909	780	853
Scania[3]	97	92	13,360	12,789	1,346	1,289
MAN Commercial Vehicles	137	114	12,104	11,087	332	362
MAN Power Engineering	–	–	3,608	3,283	193	193
VW China[4]	4,101	4,020	–	–	–	–
Other[5]	–912	–840	–34,408	–30,288	–1,557	–2,335
Volkswagen Financial Services	–	–	32,764	31,826	2,612	2,460
Volkswagen Group before special items	**–**	**–**	**–**	**–**	**17,104**	**17,041**
Special items	–	–	–	–	–3,184	–3,222
Volkswagen Group	**10,900**	**10,777**	**235,849**	**229,550**	**13,920**	**13,818**
Automotive Division[6]	10,900	10,777	201,067	195,817	11,127	11,146
of which: Passenger Cars Business Area	10,206	10,077	160,802	157,334	9,220	9,309
Commercial Vehicles Business Area	694	700	36,656	35,200	1,971	1,892
Power Engineering Business Area	–	–	3,608	3,283	–64	–55
Financial Services Division	–	–	34,782	33,733	2,793	2,673

(Source: annual report 2018)





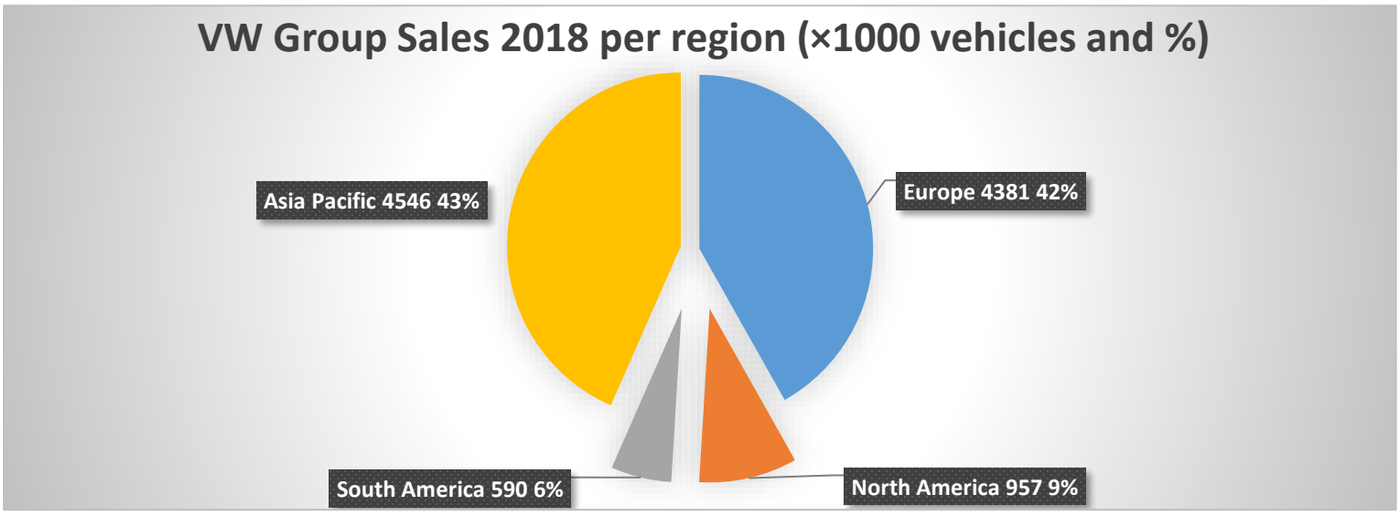


KEY FIGURES BY MARKET

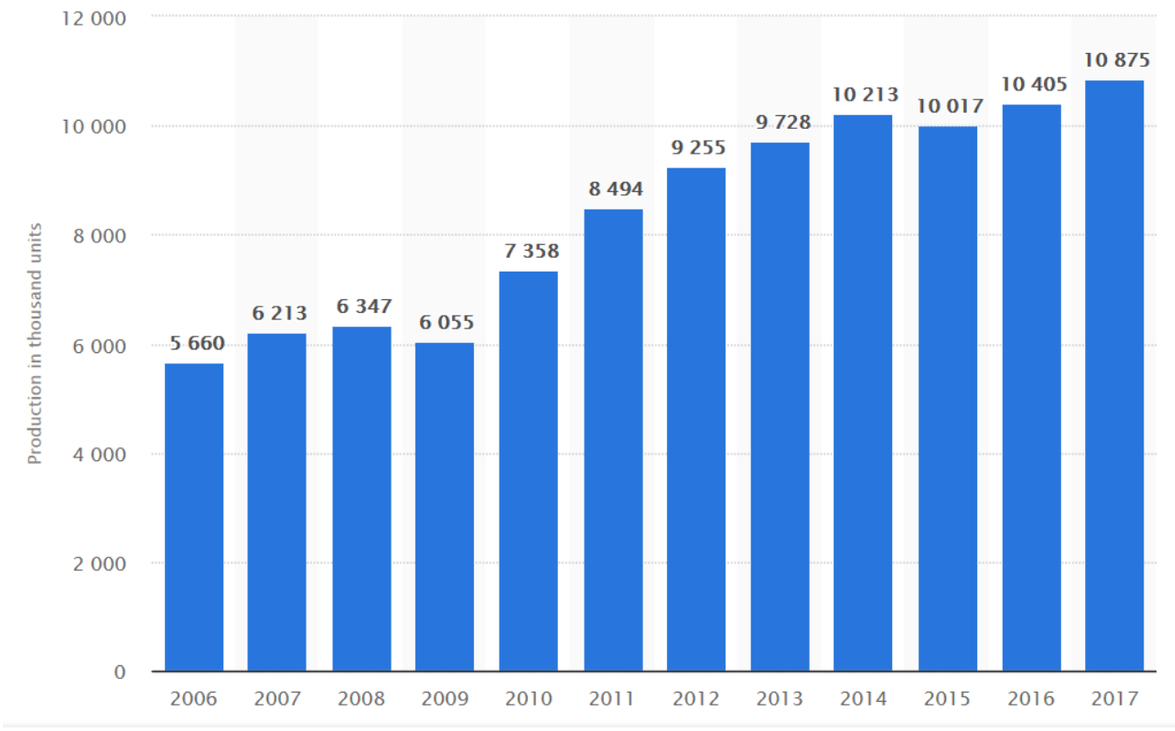
Thousand vehicles/€ million	VEHICLE SALES 2018	VEHICLE SALES 2017	SALES REVENUE 2018	SALES REVENUE 2017[1]
Europe/Other markets	4,739	4,731	143,089	142,753
North America	925	992	37,656	37,686
South America	596	526	10,405	9,988
Asia-Pacific[2]	4,640	4,527	43,166	39,123
Hedges on sales revenue	–	–	1,535	–
Volkswagen Group[2]	**10,900**	**10,777**	**235,849**	**229,550**

1 Adjusted; see disclosures about the application of new International Financial Reporting Standards on page 114.
2 The sales revenue of the joint venture companies in China is not included in the figures for the Group and the Asia-Pacific market.

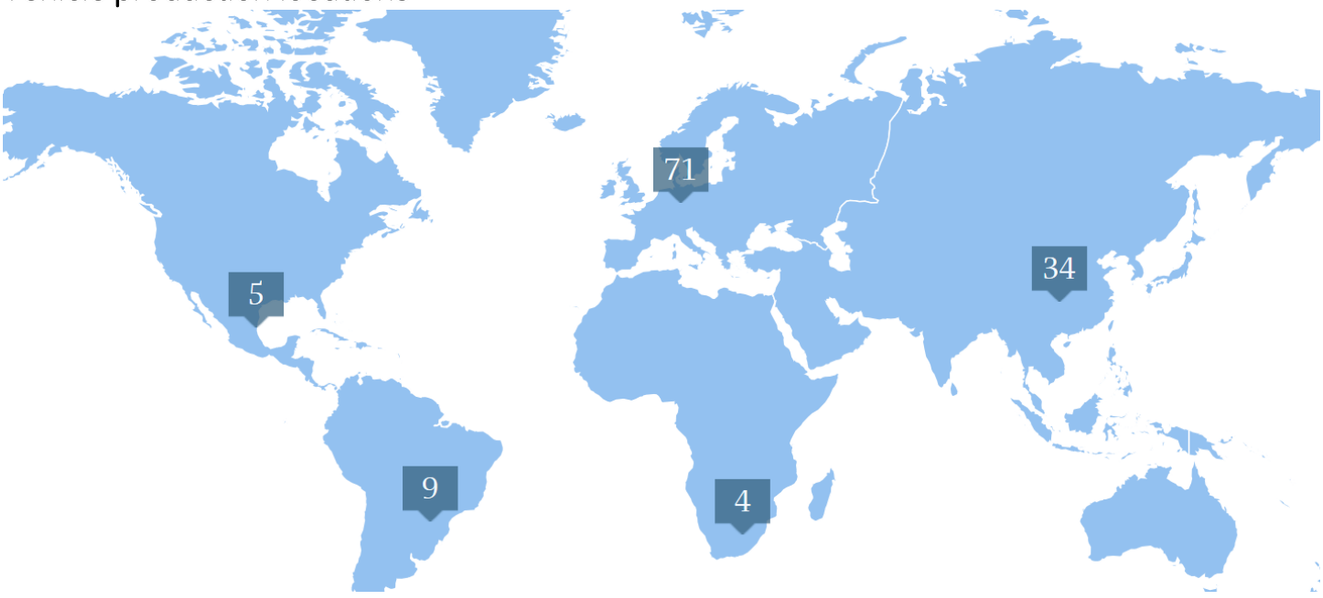
(Source: annual report 2018)



VW Group Sales, 2006 to 2017 (source: statista.com)



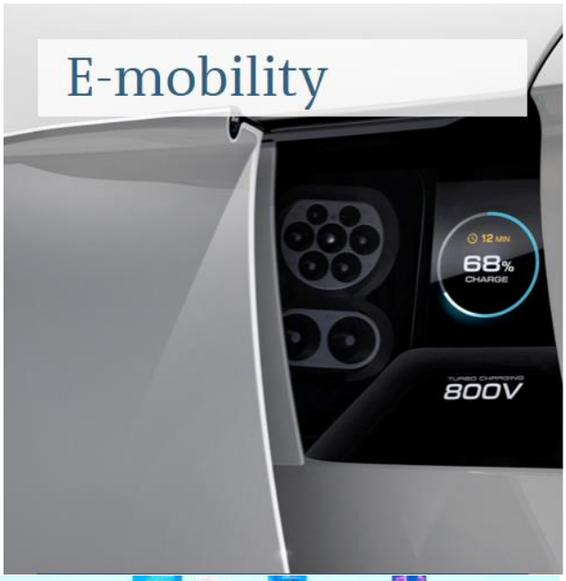
Vehicle production locations



Strategy and main targets of Volkswagen Group (per 2017 and 2018 financial report)

Volkswagen Group in 2015-2016 faced a huge issue for diesel emissions noncompliance particularly in America where the penalties to the government, users, and dealers exceeded $20bn. The company now put new attitudes and the values at the centre of their strategy. The Group are also strongly going to a new approach, to transform into a company bringing sustainable mobility to people all over the world with the following directions:

- Unique and compelling brands and products and scale potential: 12 very well-known brands with scale potential thanks to the high global number of vehicles.
- Strategy 2025 put in place with improvements of efficiency and diesel issue solved.
- E-Strategy now clearly developed: VW intend to become a major actor for electric vehicles and will be launching a further 50 fully electric cars by 2025 as well as expanding battery technology and autonomous driving as new core competences. Furthermore, a cross-brand business unit for intelligent mobility solutions is to be established as a second pillar.
- Strategic investment in on-demand mobility provider Gett was the first step in this direction; over the coming years, further services such as robotaxis, carsharing, and transport-on-demand will be grouped around this nucleus.
- Toolkit infrastructure for conventional and alternative power trains.
- Self-driving strategy with target to become software leader.
- Upside potential in core and developing markets.
- Lead position in China.
- Truck and bus global champion potential.
- Culture of willingness to change.
- Priority on protecting society and environment.
- Focusing on sustainable supplier relations.



Volkswagen Brand

Volkswagen

WOLFSBURG
GERMANY

FOUNDED IN 1937

200,266
EMPLOYEES

The Volkswagen brand is one of the world's most successful volume carmakers. The Group's core brand maintains facilities in 14 countries, where it produces vehicles for customers in more than 150 nations. In 2017, the Volkswagen brand delivered 6.23 million vehicles.

Towards e-mobility

Volkswagen Brand Executives

Dr. Herbert Diess

Chairman of the Board of Management of Volkswagen AG
Chairman of the Board of Management of the Volkswagen Passenger Cars brand

Ralf Brandstätter

Member of the Board of Management for the Volkswagen brand with responsibility for "Procurement" since 10 December 2015
Chief Operating Officer of the Volkswagen brand since 1 August 2018

Dr. Frank Welsch

Member of the Board of Management of the Volkswagen Passenger Cars brand with responsibility for Technical Development since 1 November 2015

Dr. rer. pol. Dipl.-Ing. Wirt.-Ing. Arno Antlitz

Member of the Volkswagen Brand Board of Management for Controlling and Accounting since January 1, 2010

Dr. Andreas Tostmann

Member of the Board of Management of the Volkswagen Brand responsible for Production and Logistics

Dipl.-Ing. Thomas Ulbrich

Member of the Board of Management of the Volkswagen Brand responsible for E-Mobility

Jürgen Stackmann

Member of the Board of Management of the Volkswagen Passenger Cars brand with responsibility for "Sales, Marketing and After Sales" since 1 November 2015

Thomas Schmall

Member of the Board of Management for the Volkswagen brand with responsibility for "Components" since 1 January 2015

Gunnar Kilian

Member of the Board of Management of Volkswagen AG, with functional responsibility for 'Human Resources and Organization'

Cristian Singer

Digital Car & Services

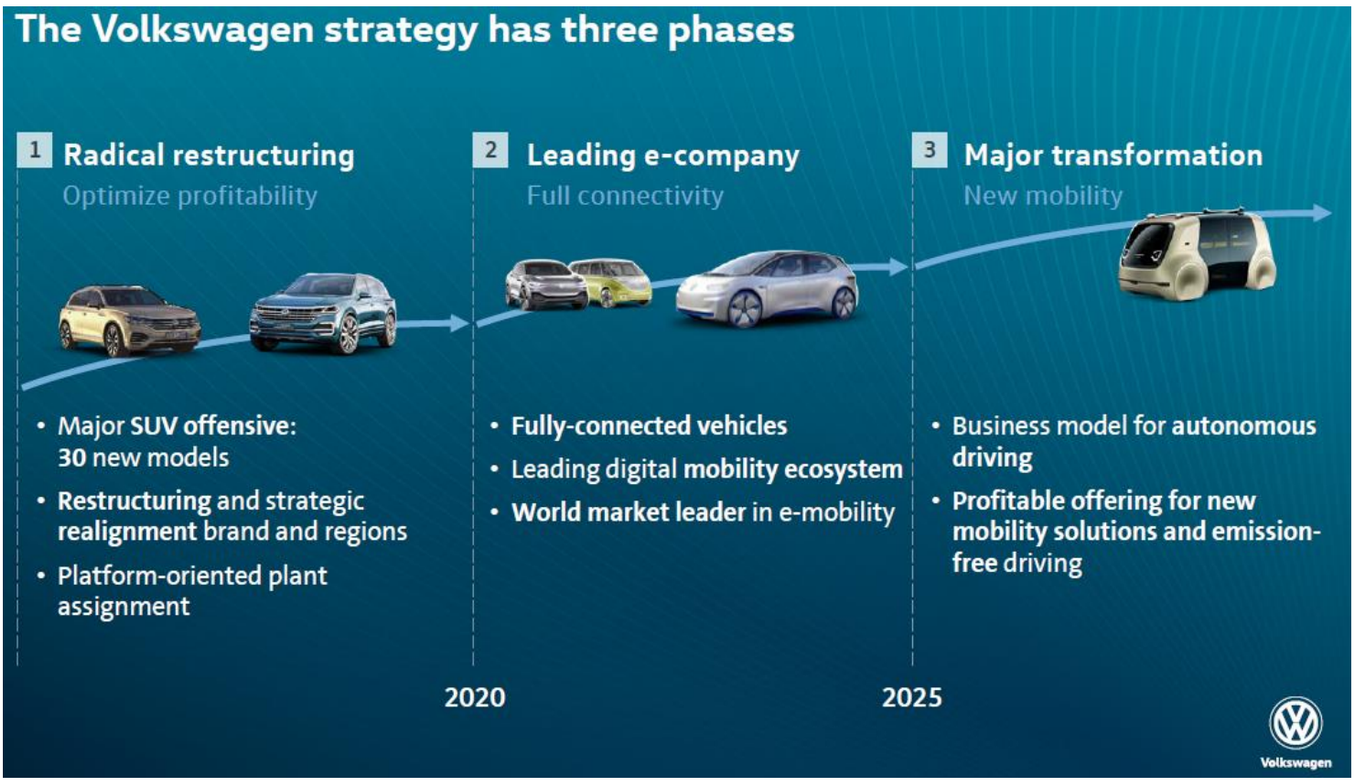
Dr. Stephan Wöllenstein

CEO VW China

Volkswagen Brand strategy

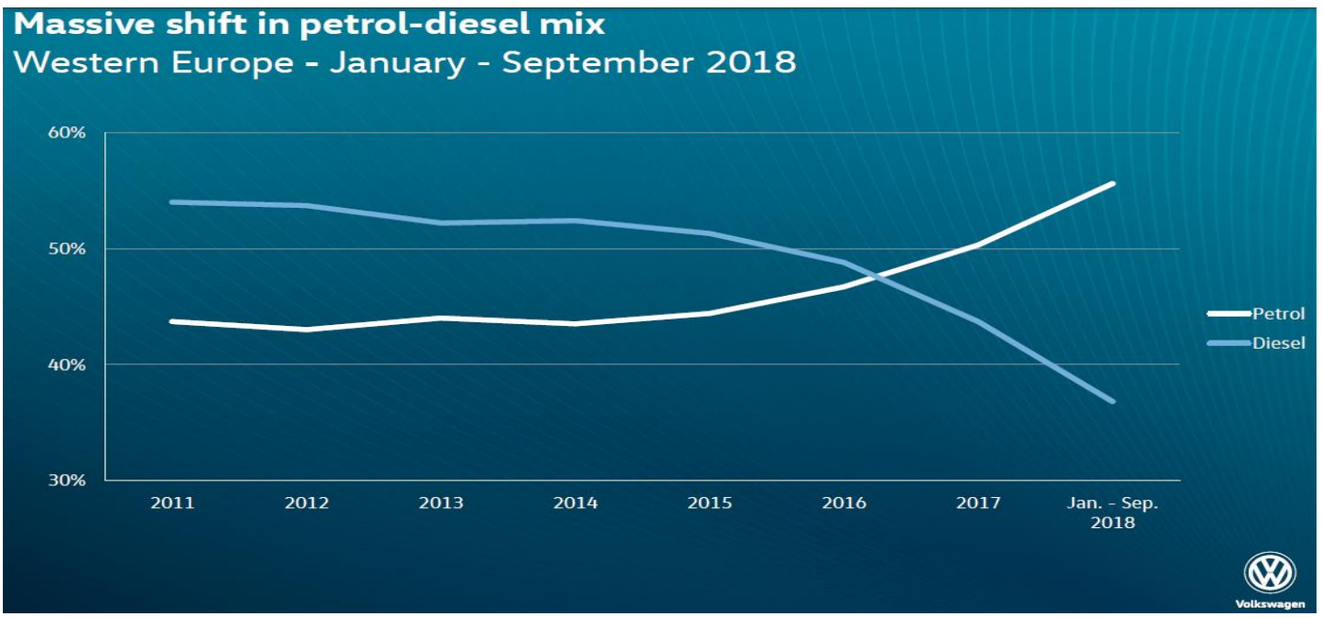
The Volkswagen Passenger Cars vision is "Moving people and driving them forwards". The "TRANSFORM 2025+" strategy therefore centres on a global model initiative through which the brand aims to lead innovation, technology and quality in the volume segment.

The intent is to launch 10 new vehicles per year and to have 20 SUVs in 2020. At that time, SUVs will account for up to 40 percent of sales volume. In the second phase from 2020, VW will launch a new generation of fully-connected electric cars targeting to sell one million in 2025 and to be the industry benchmark with their Modular Electric Toolkit called MEB.



Volkswagen brand productivity and efficiency plan

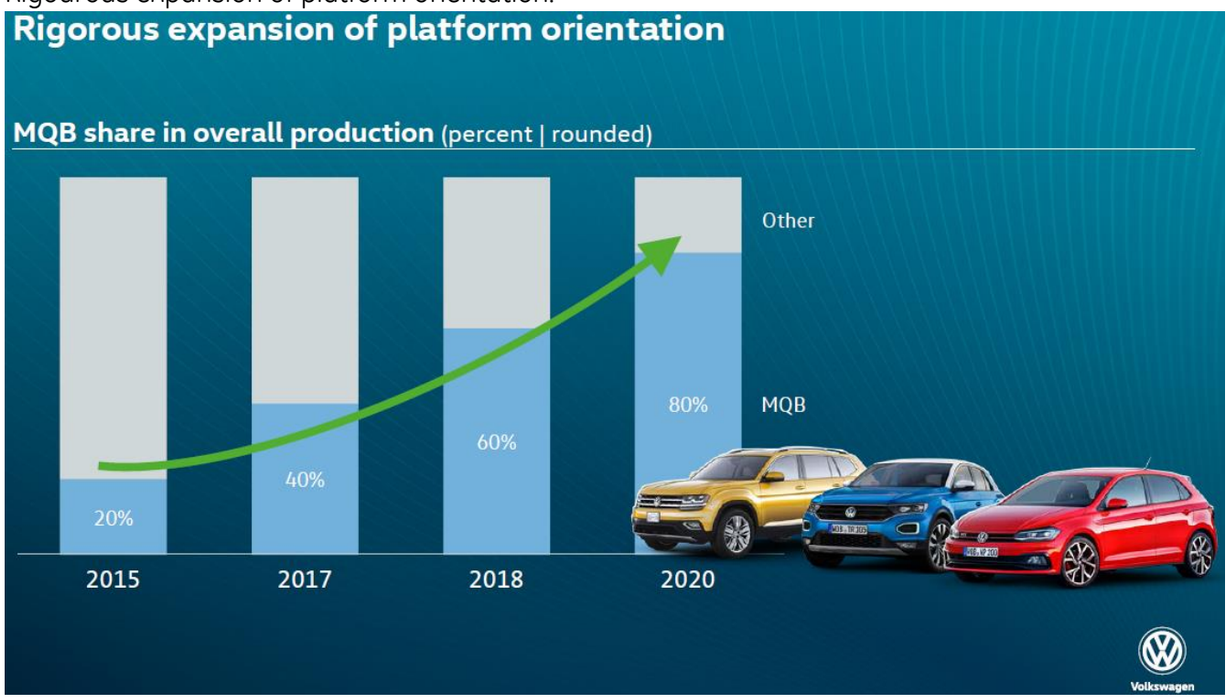
The current context is difficult for Volkswagen due to the diesel issue, the WLTP homologation procedure, the very quick change in the mix of diesel/petrol, the possible end of the expansion cycle, the current international tensions, and the challenges in relation to the major changes to prepare for electric, connected, and autonomous cars. Example of these constraints with the petrol-diesel mix change:



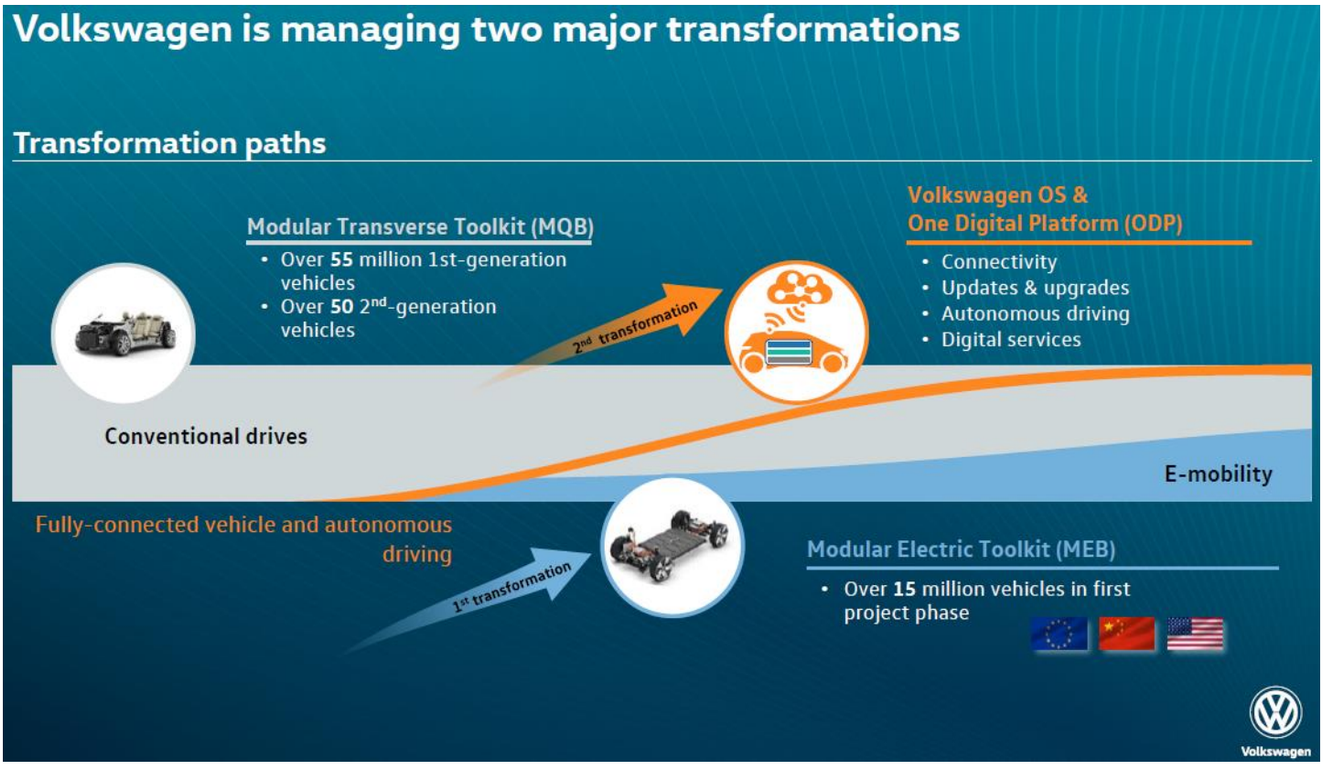
Some of the international tensions as of end 2018:

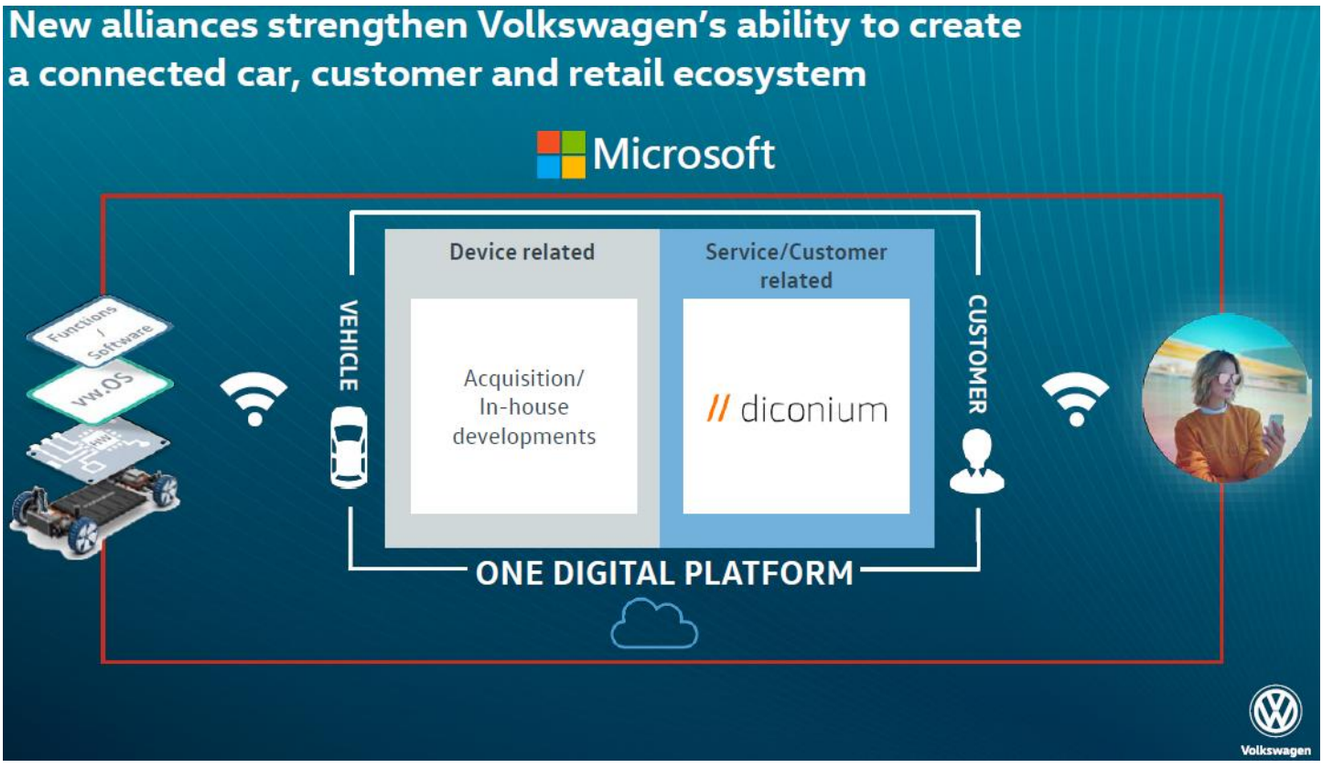
Volkswagen have prepared a package of measures for more productivity and efficiency to 2025 including:

- Rigourous expansion of platform orientation:



- Increased efficiency in plants; the aim is to achieve +30% efficiency with -30% investment by 2025.
- Reduced complexity with fewer variants. For instance, from Golf 7 to Golf 8, wheel rims down by 40% and steering wheels down by 60%.
- Optimise material cost by value engineering with reduced variants, simple technical solutions, low component complexity, and region-specific solutions.
- Lean administration and less bureaucracy with optimised hierarchy levels.


Volkswagen is managing two major transformations
Transformation paths
Modular Transverse Toolkit (MQB)
• Over 55 million 1st-generation vehicles
• Over 50 2nd-generation vehicles
2nd transformation
Volkswagen OS & One Digital Platform (ODP)
• Connectivity
• Updates & upgrades
• Autonomous driving
• Digital services
Conventional drives
E-mobility
Fully-connected vehicle and autonomous driving
1st transformation
Modular Electric Toolkit (MEB)
• Over 15 million vehicles in first project phase
Volkswagen


New alliances strengthen Volkswagen's ability to create a connected car, customer and retail ecosystem
Microsoft
Functions / Software
vw.OS
VEHICLE
Device related
Service/Customer related
Acquisition/ In-house developments
// diconium
CUSTOMER
ONE DIGITAL PLATFORM
Volkswagen


ID. family: it's not an evolution, it's a revolution
"100% emission-neutral"
Volkswagen

Volkswagen History

Volkswagen maintain a detailed chronicle of company history, currently up to 348 pages, called "From the Beetle to a Global Player". Some highlights:

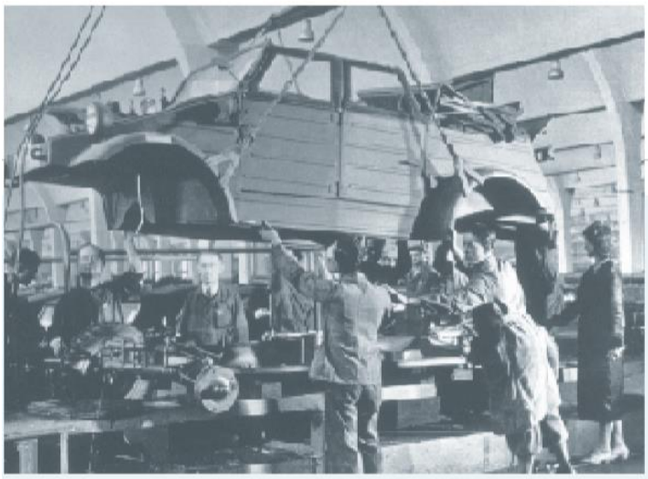
- **1934–1937: The German People's Car as a Communal Project:**
  On 17 January 1934, Ferdinand Porsche submitted to the Reich Ministry of Transport a memorandum on the construction of a German People's Car, setting forth a "fully practical vehicle" for four adults, "of normal size but relatively light weight", with a cruising speed of 100 km/h, suitable for the recently built autobahn network. In May 1934, the Reich Automotive Industry Association (RDA) decided to develop a it as a "communal project" and signed a contract on 22 June 1934 commissioning Ferdinand Porsche's office to handle the engineering and design.

FERDINAND PORSCHE

VW3 PROTOTYPE

Through late 1936 three V3 prototypes were each subjected to a 50,000 kilometre test.

- 1937–1945: Founding of the Company and Integration into the War Economy



On 28 May 1937, the Deutsche Arbeitsfront (DAF) in Berlin established the Gesellschaft zur Vorbereitung des Deutschen Volkswagens, or "Corporation to prepare the way for the German People's Car". On 16 September 1938, the company was renamed Volkswagenwerk GmbH. In February 1938, work began on a site east of Fallersleben on the Mittelland canal to construct the main plant, inspired by Ford's River Rouge plant in Detroit. This main plant is what is today Wolfsburg. The target was to produce 150,000 units in the first year after the plant's scheduled opening in Autumn 1939, and 300,000 in the second year, with capacity increasing to 450,000 units by the year after. The medium-term target was to build 1.5 million "People's Cars". The workforce was planned to grow from 7,500, to 14,500, and ultimately to 21,000 people.

But not a single car had been produced by the time the war began on 1 September 1939. During the war, the plant produced mainly mass production of military utility vehicles (Kübelwagen) that was stopped by the US troops who arrived on April 11, 1945.

- 1945–1949 The Work of the British

The British Military Government took over the administration of the firm in trusteeship in June 1945. They decided to reinstate peacetime production and the assembly line manufacturing of the Volkswagen sedan. In spite of the damage inflicted on the factory buildings, the machine park, which was moved to dispersal sites, survived the Allied bombings largely untouched. Despite British protection, the shortage of material and power seriously impaired production of the Volkswagen sedan after it was started on 27 December, 1945.

The monthly production rate was finally limited to 1,000 vehicles a month, a figure that remained stable until the currency reform and the introduction of the Deutschmark.

The British authorities took two major decisions for the future: First, the organisation of a good sales network. And in the summer of 1947, they decided to export Volkswagens. It was aimed at replenishing the currency reserves of a British economy still reeling from the financial costs of the war, but it also laid the foundation for the international success of the Volkswagen sedan and the company's launch onto the global marketplace. In 1948, 4,385 vehicles were exported to European countries, and 7,127 vehicles in 1949, so 15% of the global production.

During that time, the British Senior Resident Officer, Major Ivan Hirst, played a decisive role in the conversion of the armaments factory into a car company. Hirst steadfastly pressed for improvements in the quality of the car, and this was to become an important factor in Volkswagen's international reputation

In February 1946, the British appointed the lawyer Dr. Hermann Münch as the chief trustee of Volkswagenwerk GmbH; he also becomes General Director on 17 June. In January 1948, the former Opel manager Heinrich Nordhoff took up his post as General Director of Volkswagenwerk GmbH.

On April 26, 1948 it was decided to move the head office from Berlin to Wolfsburg .

On 8 October 1949, the British Military Government turned over the trusteeship of Volkswagenwerk GmbH to the German Federal Government and its administration to the State of Lower Saxony. The company was in good condition. It had approximately 10,000 employees, a monthly production output of 4,000 vehicles, and built just under half of all the cars produced in West Germany.

- 1950-1960 Internationalisation and Mass Production in the Era of Germany's Economic MiracleIn 1950, Volkswagen was already considered a symbol of West Germany's Economic Miracle, or Wirtschaftswunder, even by its contemporaries. The company's success matched that of the Beetle itself. In 1950, the Wolfsburg company exported one third of its car production to 18 countries, most of them in Europe. On 8 March 1950, mass production of the Transporter began in Wolfsburg. While the

Transporter adopted some technical features from the beetle, such as its air-cooled rear-mounted engine developing 25 hp, it is provided with a reinforced chassis.

On 11 September 1952, Volkswagen Canada was founded in Toronto, Ontario. On 23 March 1953 comes the first foreign production company, Volkswagen do Brasil in São Paulo.

The factory's capacity as well as the rationalisation initiative introduced in 1954 created the technical preconditions for mass production of the Volkswagen sedan and the Transporter. Nordhoff requested efficiency investments in cutting and non-cutting machining, as well as an expansion of capacities by around a quarter to a daily output of 1,250 passenger cars and 220 Transporters.

As a public company, Volkswagenwerk GmbH had the support of the Federal Government which, by negotiating trade agreements, opened up export possibilities for German industry. With a share of up to 50 percent of all German car exports, Volkswagen were the most important earner of foreign currency and the leading German car exporter during the 1950s. The Volkswagen sedan was the best-selling car of the decade, achieving a market share of around 40 percent. In the international markets, The Beetle enjoyed the reputation of being an economical and reliable car, especially suited to the needs of developing countries because of its fuel efficiency and its robust design suitable for regions with underdeveloped roads. Volkswagenwerk AG, which was entered in the Register of Companies on August 22, 1960, were able to continue successful development after privatisation.

On 14July 1955, the Karmann-Ghia coupé was launched in Georgsmarienhütte, Lower Saxony: a stylish, sporty Italian design with 30-horsepower engine, hydraulic brakes, and front axle stabiliser.

NEW PRODUCTION RECORD

VOLKSWAGEN KARMANN GHIA COUPE

In July 1955, Volkswagen United States was founded in New York as a market research and observation instrument. The next month, employees and dealers from Germany and abroad celebrated the production of the one millionth Volkswagen in Wolfsburg. That October, Volkswagen of America replaced Volkswagen United States. In 1956, 42,884 Beetles and 6,666 Transporters were sold in the USA, and after a one-year construction period, the new plant in Stöcken near Hanover started producing the Transporter. Yearly production reached 91,993 units in 1957.

In late 1959, the new car factory in São Bernardo do Campo, Brazil was officially opened. In 1961, Volkswagen do Brazil led the Brazilian car industry, selling a total of 47,320 vehicles. Its market share grew to 41 percent, while the workforce of more than 8,000 produced nearly 220 vehicles each working day. Meanwhile, Volkswagenwerk GmbH was transformed into a stock corporation, and the new Volkswagenwerk Aktiengesellschaft (VW AG) was entered in the Register of Companies at the District Court in Wolfsburg. 60 percent of the company's stock was sold as "people's shares". The remaining 40 percent was divided equally between the Federal Government and the State of Lower Saxony, thus safeguarding state influence over the company.

1961–1972: Boom and Crisis in the One-Product Business

At the 1961 IAA International Motor Show in Frankfurt, Volkswagen presented the 1500, a mid-class sedan with a 45-horsepower boxer engine in the rear. Designated as the type 3 internally, it was a "big brother" for the Beetle. Meanwhile the Karmann Ghia coupé launched commercially the same year had less success than expected.

In January 1964 the establishment of Volkswagen de Mexico in Puebla marked Volkswagen's transition from assembly to production after new import controls had made importing Volkswagen vehicles into Mexico increasingly difficult. To meet growing demand, a new production site was established in Puebla in November 1967.

In January 1965, Auto Union in Ingolstadt was acquired by Volkswagenwerk AG from Daimler-Benz AG in three share tranches. By assuming ownership of this traditional and innovative brand, the Volkswagen Group widened their product range. At the same time, Volkswagen also gained access to a new generation of engines. In 1967, the production was still dominated by the Beetle:

Type 1 "Beetle"	Transporter	VW 1500
925,787	162,741	201,800

In May 1968, Kurt Lotz, Deputy Chairman of the Board of Management since June 1967, succeeds Heinrich Nordhoff who ruled the company for 20 years.

VW 411

KURT LOTZ

1968 saw the launch of a new model, the 411. Despite interesting technical features, it was not as big a hit as was hoped, with sales in 1969 totalling just 46,467 units. Volkswagenwerk AG and AB Scania Vabis entered into a consortium agreement by which Volkswagen acquired a one third share in Svenska Volkswagen AB, based in Södertälje. In 1969, Auto Union and NSU Motorenwerke merged to form Audi NSU Auto Union; Volkswagenwerk owned 59.5 percent of the shares. At the IAA International Motor Show Volkswagen present the new VW-Porsche 914, a joint venture between Volkswagenwerk and Dr.-Ing. h.c. F. Porsche.

In 1970, the first K 70 front-wheel drive and water-cooled Volkswagens roll off the production line at the newly constructed plant in Salzgitter, but The selling crisis of the K 70 and the onset of the worldwide recession in 1974-'75 brings car manufacture at Salzgitter to an end in September 1975.

February 17th, 1972: with 15,007,034 units produced, the Beetle breaks the record of the legendary Tin Lizzy, the Ford Motor Company's Model T built from 1908 to 1927. The Beetle is the new World Champion.

1973-1981: Water Cooling

May 14th, 1973: The Passat, the first model of the new Volkswagen generation, goes into production at the Wolfsburg plant.

The Scirocco, a two-door sports coupé styled by Giugiaro, went into production at coachbuilder Karmann in Osnabrück. Based on the technical concept for the Golf, the Scirocco was characterised by its striking design, innovative technology, and high degree of everyday practicality. Production of the Golf began in Wolfsburg in 1974. With its straight lines, compact Giugiaro design, and water-cooled front-mounted engines developing 50 and 70 hp respectively, the model represented a landmark new concept.

Thanks to these new models, the production became more balanced—but the Beetle was still the major product in 1974:

Volkswagenwerk AG	Group	Type 1 "Beetle"	Transporter	Passat	Golf
1,239,698	2,067,980	791,053	222,233	340,589	189,890

In 1975, Production of the Polo began in Wolfsburg. Just three and a half metres long, but offering as much as 900 litres of luggage capacity, the low-cost compact was largely identical in design to the Audi 50.

From 1974 to 1975, production dropped despite the success of the Golf. To reduce the personnel overhang linked to the dramatic collapse in sales, the company's workforce was reduced by 32,761. Production in 1975:

Volkswagenwerk AG	Group	Transporter	Passat	Golf	Polo
1,121,937	1,948,939	221,351	258,953	419,620	74,180

In 1976, in response to pressure from the downward Dollar exchange rate impacting on Volkswagen exports to the USA, Volkswagen Manufacturing Corporation of America was established to build up production in the USA. The new subsidiary acquired a press plant in South Charleston, West Virginia, and

an assembly plant in Westmoreland, Pennsylvania, where production of the Golf for the North American market begins in April 1978. In 1979, the third generation of the Transporter was presented to the media in Wolfsburg, and the Wolfsburg plant started building the Jetta, a mid-size notchback filling the gap in the range between the Passat fastback sedan and the compact Golf.

Late in 1980, the second-generation Passat was launched in Ascona in the Ticino (Tessin) area of northern Italy. The fastback model and its Variant estate version were enhanced in their styling and made bigger inside than their predecessors.

Production in 1980:

Volkswagenwerk AG	Group	Transporter	Passat	Golf	Polo
1,346,755	2,573,871	217,876	265,627	831,527	126,860

1982–1991 New Brands & Markets

On 1 January 1982, Carl H. Hahn became Chairman of the Board of Management of Volkswagenwerk AG. In 1985 came the joint venture Volkswagen Shanghai Automotive Company; China was at the core of the company's Asian involvement. Chinese reform policies and industrial development opened the way to a market of great future potential. Conversely, the Chinese leadership trusted Volkswagen because of their pioneering development of the automotive industry in Brazil and Mexico.
The assembly contract signed in 1982 with the Shanghai Tractor & Automobile Corporation was the precursor to a successful German-Chinese undertaking which began on April 11, 1983 when the first VW Santana built in China rolled off the production line and was further enhanced in 1985 with the founding of the joint venture Volkswagen Shanghai Automotive Company, Ltd. As capacity increased, the joint venture became China's largest passenger car producer and made Volkswagen the market leader in that country.

In 1986, after a period of successful coöperation, Volkswagen AG initially acquired 51 percent of the shares in Spanish carmaker SEAT, who were integrated into the Volkswagen Group as a third independent brand. In 1989, immediately after the opening of the border between East and West Germany, Volkswagen pushed into the East German market, utilising their long-standing business relationship with the car industry in Saxony.

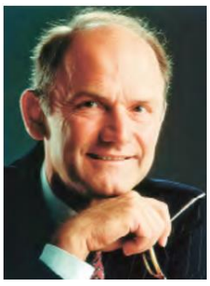
In 1991, the organisational structure of the Volkswagen Group was adapted to reflect the brand alliance. A new Brand Management Board was now responsible for the operations of the Volkswagen brand. The Group Management Board decided on all cross-brand matters. Czech car-maker Škoda joined the Volkswagen Group as a fourth independent brand, bringing a highly skilled workforce and a yearly capacity of 190,000 vehicles. Volkswagen put the finishing touch on their involvement in Czechia with the car-maker Bratislavské Automobilové Závodi that led to the establishment of Volkswagen Bratislava, took over a manufacturing complex with a fully developed infrastructure, and started producing Passats there in December 1991.

Meanwhile, Volkswagen AG and the Ford Motor Company established the joint venture AutoEuropa Automóveis in Palmela, Portugal. Aimed at sharing capital commitment and risk, the enterprise is set up to exploit opportunities in the booming multi-purpose vehicle (MPV) market segment. On July 12th, 1991, the first more rounded design third-generation Golf rolled off the production line at the Wolfsburg plant.

1991 Production:

Volkswagen AG	Group	T4	Passat	Golf	Polo
1,576,086	3,128,338	137,682	427,395	808,100	325,282

1992–2014 Globalisation of the Mobility Group



The Volkswagen Group initiated a strategic change of direction during the severe global recession of 1992-'93. While the 1980s was a time of internationalisation and volume policy, Volkswagen now concentrated more on product diversity as well as on improving productivity and earning power: factories built in the early 1990s were models of lean production, and productivity in the Volkswagen Group rose by almost 30 percent between 1994 and 1996. In January 1993, Ferdinand Piëch became Chairman of the Board of Management of Volkswagen AG. Late that year the new Passat sedan and wagon were launched.

In Spring 1994, VW took over Fábricia Navarra de Automóviles, who built the Polo in Pamplona, Spain. The company were renamed Volkswagen Navarra, and in the course of the year produced just under 146,000 vehicles. The third-generation Polo, offered for the first time in a four-door version, was presented to the media in Paris. In Spring 1995, the new Volkswagen Sharan MPV (photo) celebrated its world premiere in Geneva. On November 17th, 1995, Volkswagen Argentina opened a new car plant with an annual capacity of 150,000 vehicles in Pacheco, near Buenos Aires. The plant built the successful Golf model and from 1996 the Polo as well.

Production in 1995

Volkswagen Aktiengesellschaft	Group	T4	Passat	Golf	Polo
1,317,656	3,408,422	141,355	260,169	815,875	382,785

1996 brought the fifth generation of Passat; 1997 the fourth generation of Golf.

In January 1998, the New Beetle had its world premiere at the Detroit motor show—not so much a daughter of the legendary Beetle, but rather a sister to the new Golf.

The Volkswagen Group extended their portfolio in the luxury segment by procuring the Bentley brand, as well as the Bugatti International holding company, which owned the rights to that famous old brand name. The Lupo model (left) was presented to the media in Geneva; it represented a new attractive offering from Volkswagen in the growing small-car segment.

In 2000 the third car factory built by Shanghai Volkswagen, complete with press plant, body shop, paint shop and assembly line, started production. The facility built the extended Chinese version of the Passat sedan.The "Autostadt" opens in Wolfsburg, a combination of visitor experience, service facility, and centre of excellence.

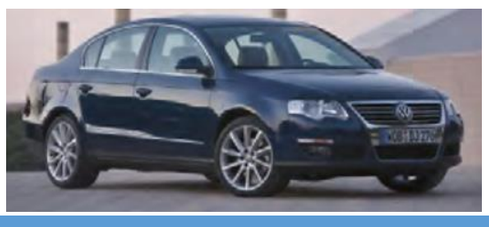
2000 production:

Volkswagen Aktiengesellschaft	Group	T4	Passat	Golf	Polo
1,170,411	5,156,455	162,699	631,852	915,383	463,163

On December 11th,2001, just under two and a half years after the foundation stone was laid on July 27, 1999, Volkswagen opened the "Gläserne Manufaktur" glass-fronted manufacturing showcase in Dresden.

In 2002, the Phaeton had its world premiere at the Geneva Motor Show. The 5.06-metre long, 1.90-metre wide and 1.45-metre high notchback sedan was Volkswagen's first entry into the luxury car class.

The Touareg had its world premiere at the Paris Motor Show, and 2003 brought the 5th generation of Golf—as well as world's the last air-cooled Beetle, built in Mexico.



2005: the sixth-generation Passat premiered at the Geneva Motor Show.

Production 2005:

Volkswagen Aktiengesellschaft	Group	T5	Passat	Golf	Polo
956,108	5,219,478	177,956	578,141	732,922	352,120

To establish a production facility in Russia, Volkswagen created a new company in 2006, OOO Volkswagen RUS, based in Kaluga, some 160 kilometres south west of Moscow. Dr. Ing. h.c. F. Porsche AG announced their intent to acquire approximately 20 percent of the voting share capital in Volkswagen AG. Martin Winterkorn, appointed by the Supervisory Board as Chairman of the Board of Management of Volkswagen AG, formally took up his post. The Tiguan compact SUV was exhibited at the Geneva Motor Show.

In 2008 the new Passat CC mid-class premium model, built at the Emden plant, was launched at the Detroit motor show. The fourth generation of the Volkswagen Scirocco entered production at the company's plant in Setubal, Portugal.

- In September 2008, the media presentation of the sixth-generation Golf took place in Iceland. A new VW plant opened in Pune, India, with annual capacity to produce 110,000 vehicles. Following a €580m investment, the plant began production of the Škoda Fabia compact. A Polo model developed specially for the Indian market followed in late 2009. VW AG and Porsche Automobil Holding agreed in principle to create an integrated automotive concern incorporating Porsche under the leadership of Volkswagen. The new-generation Sharan had its world premiere at the Geneva Motor Show. The second generation of the Touran, built at the Wolfsburg plant, premiered at the Auto Mobil International motor show in Leipzig. In 2010 the VW Group bought 90.1 percent of the shares in Italdesign Giugiaro, including the name rights and patents.

2010 Production:

Volkswagen Aktiengesellschaft	Group	T5	Passat	Golf	Polo
1,100,186	7,357,505	168,019	994,956	828,910	635,556

In 2011, implementing the agreement in principle signed with Porsche in 2009, Volkswagen acquired Porsche Holding Salzburg. The world premiere of the Up at the Frankfurt Motor Show marked a new milestone in the small car segment. VW AG held 55.90 percent of the voting rights and 53.71 percent of the share capital in MAN SE—a majority interest. This was a major step in the company's strategy of creating a commercial vehicles group comprising MAN, Scania and the Volkswagen Commercial Vehicles brand. The Volkswagen Group China and Chinese partners of Shanghai Volkswagen. signed a contract to build a new plant in Ningbo, southern China, with annual production capacity for 300,000 vehicles.

In 2012 the New Lavida A-segment notchback sedan built by Shanghai Volkswagen debuted at the Auto China show.
The seventh-generation Golf (below) had its world premiere in Berlin.
Shanghai VW opened a new plant in Yizheng, eastern China, a model of environmental sustainability and designed to produce 300,000 vehicles a year with a workforce of 3,700 people. The transfer into VW AG of the 50.1 percent share in Porsche created an integrated automobile concern combining Volkswagen and Porsche. Through an intermediate holding company, Volkswagen thus owned 100 percent of the shares in Porsche AG, now operating as an independent Group brand.
The new Santana built by Shanghai Volkswagen launched in Wolfsburg, where the first generation of the model was launched 31 years ago.

In 2013, aiming to increase production capacity in China to four million vehicles a year by 2018, Volkswagen signed an agreement with Chinese joint venture partner Shanghai-Volkswagen to build a plant at Changsha in southern China, designed to build 300,000 vehicles a year. At the Frankfurt International Motor Show (IAA), Volkswagen showed electric Golf and Up models. FAW-Volkswagen's new plant opened at Foshan in southern China; the first product to roll off its assembly line was the seventh-generation Golf for the Chinese market. The plant offered annual production capacity for 300,000 units. The newly-opened plant designed to produce 300,000 units per year at Ningbo in southeastern China started production of the Škoda Superb. The following year it also started building the Škoda Octavia, as well as the Volkswagen Lamando.

Production of the e-Golf started in Wolfsburg in 2014. The newly constructed "E-Campus" competence centre for electrical and electronic engineering bundled key development functions for vehicle electromobility and connectivity. This centre is a futuristic eight-storey building, covering a total area of 42,900 square metres. The Golf GTE launched as VW's first plug-in hybrid.

2014 production:

Volkswagen Aktiengesellschaft	Group	T5	Passat/Magotan	Golf	Polo
1,230,891	10,212,562	178,283	747,583	1,011,124	753,754

Volkswagen Brand Main Figures

Vehicles units sold worldwide in 2017 and 2018

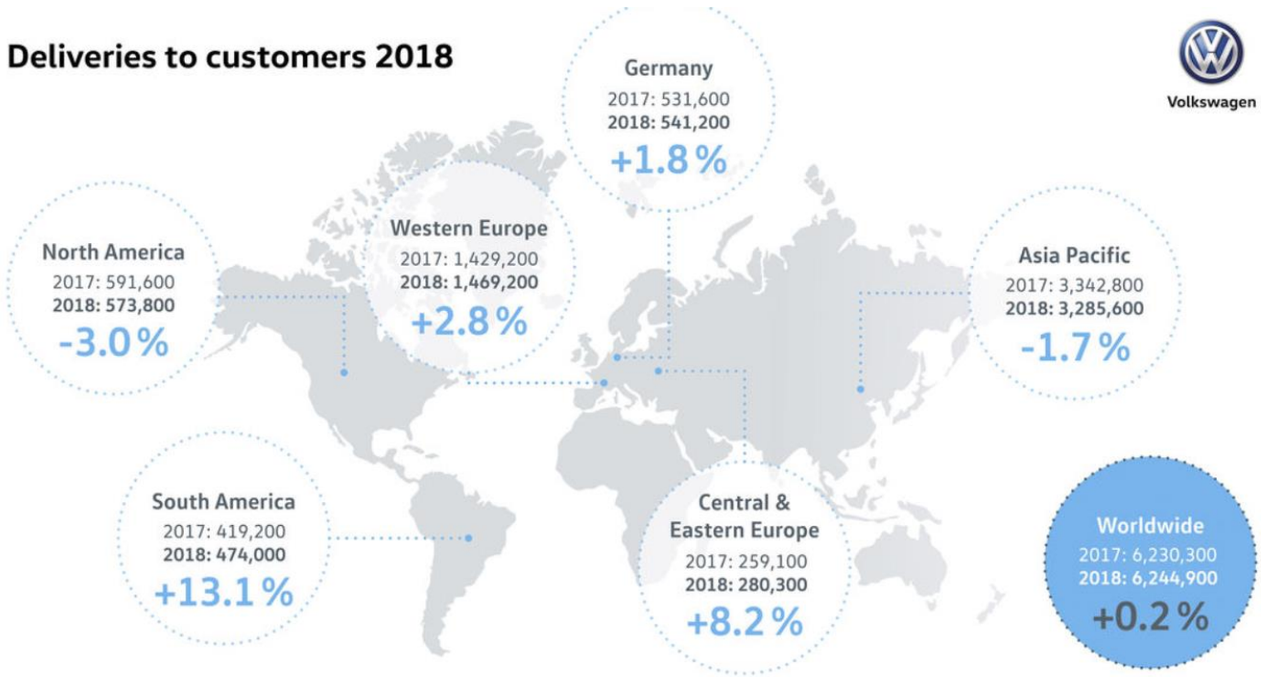
Units	2018	2017
Tiguan	861,331	769,870
Polo/Virtus	855,179	755,506
Golf	805,752	968,284
Jetta/Sagitar	770,447	883,346
Passat/Magotan	656,249	660,996
Lavida	513,556	507,574
Santana	272,080	293,313
Bora	269,390	334,900
T-Roc	236,977	22,724
Atlas/Teramont	166,034	129,724
Gol	156,410	203,148
Lamando	141,076	138,943
up!	136,512	158,795
Touran	130,417	144,676
Saveiro	59,233	66,431
Arteon/CC	49,735	37,972
Fox	40,596	50,739
Touareg	40,387	42,407
Beetle	37,846	59,483
Sharan	30,459	45,695
Tharu	26,986	–
Phideon	24,102	13,014
Suran	16,356	21,093
Scirocco	–	8,199
	6,297,110	**6,316,832**

source: 2018 annual report

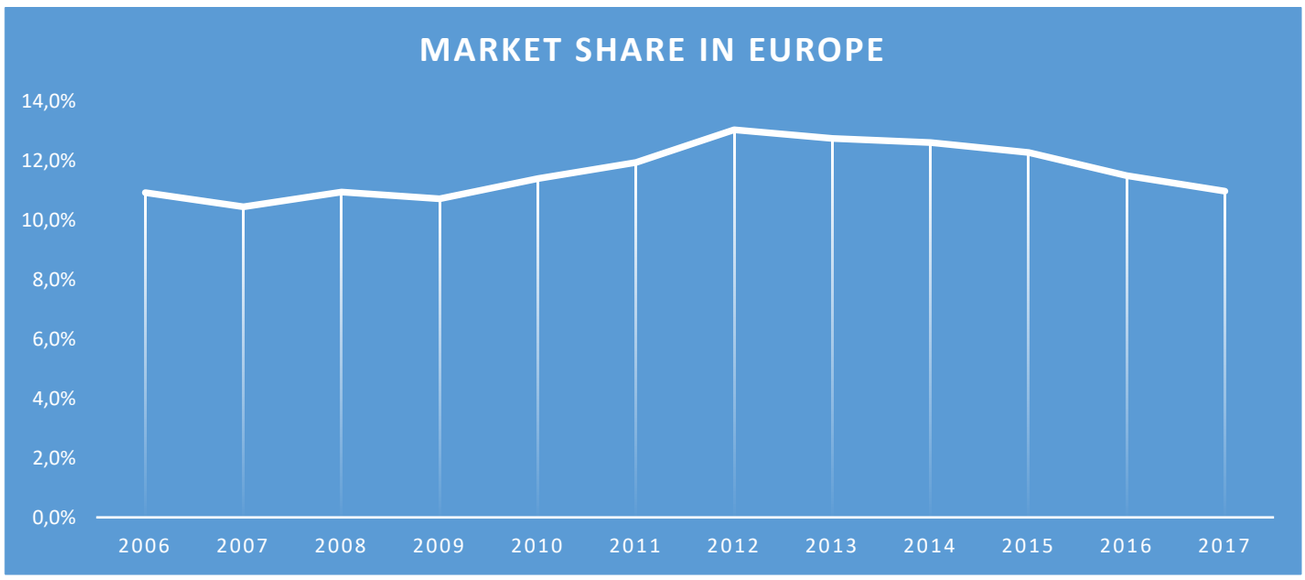
Volkswagen brand worldwide position in 2017 (source: carsalesbase)

	Brand*	Sales	ΔYoY
1	TOYOTA	7,843,423	+5%
2	VOLKSWAGEN	6,639,250	+3%
3	FORD	5,953,122	-2%
4	HONDA	4,967,689	+7%
5	NISSAN	4,834,694	+5%
6	HYUNDAI	3,951,176	-9%
7	CHEVROLET	3,857,388	0%
8	SUZUKI	2,891,415	+11%
9	MERCEDES	2,534,181	+13%
10	KIA	2,511,293	-10%
11	RENAULT	2,275,227	+7%
12	BMW	2,030,331	+5%
13	AUDI	1,847,613	+1%
14	PEUGEOT	1,590,300	0%
15	FIAT	1,503,806	+1%

Volkswagen brand sales 2018: new record with 6,244,900 vehicles sold



Sales in Europe (Passengers cars - Volkswagen brand only)



The market share of Volkswagen brand is back to 12% in Europe in 2018.

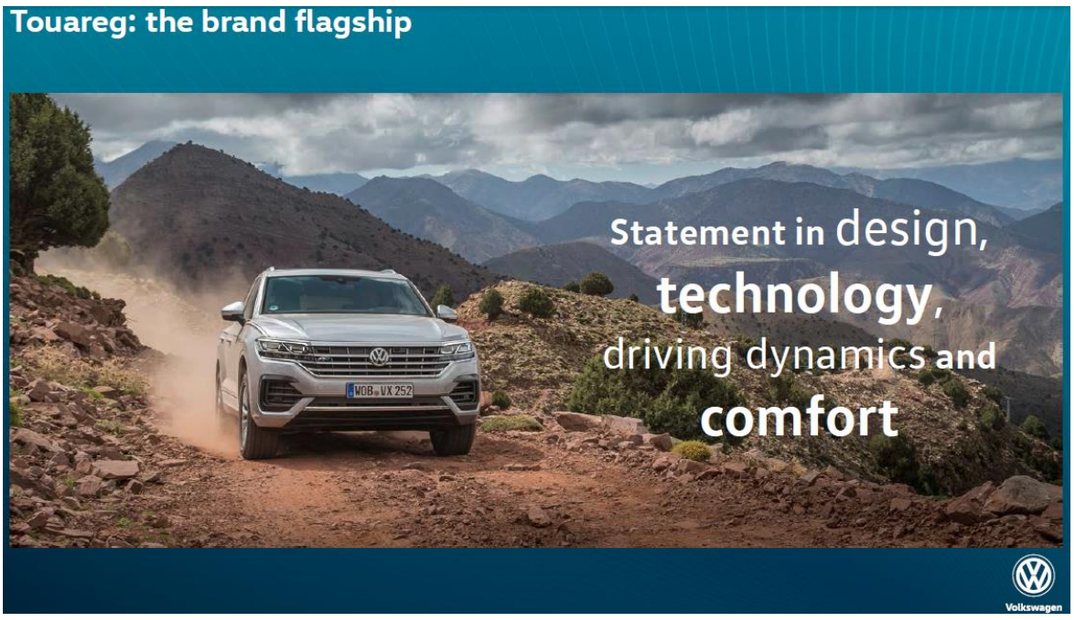
EUROPE	VW	TOTAL	MARKET SHARE
2006	1613	14763	10,9%
2007	1546	14793	10,5%
2008	1484	13561	10,9%
2009	1465	13665	10,7%
2010	1479	12977	11,4%
2011	1529	12808	11,9%
2012	1535	11770	13,0%
2013	1473	11552	12,8%
2014	1527	12111	12,6%
2015	1620	13191	12,3%
2016	1599	13907	11,5%
2017	1572	14318	11,0%

	2018	2017[1]	%
Deliveries (thousand units)	6,245	6,230	+0.2
Vehicle sales	3,715	3,573	+4.0
Production	6,297	6,317	–0.3
Sales revenue (€ million)	84,585	79,186	+6.8
Operating result before special items	3,239	3,301	–1.9
Operating return on sales (%)	3.8	4.2	

1 Sales revenue adjusted; see disclosures about the application of new International Financial Reporting Standards on page 114.

Volkswagen Cars

New cars (2018)




T-Cross: rounds off the SUV offering
Combination of diversty,
Connectivity and
outstanding Design
WOB TC 121
Volkswagen


Virtus: new model for the South America strategy
Superior package
with emotional design and latest connectivity features
Volkswagen


Jetta: the seventh generation of the global bestseller
generous space and efficient drive technology
Volkswagen

Complete range of Volkswagen cars (not including all variants)

up!

up! GTI

Fox (South America)

SpaceFox/Suran (South America)

CrossFox (South America)

Polo (India / South America)

Gol (South America)

Ameo (Russia/India)

Polo

Saveiro (South America)

Golf

Golf Estate TGI

e-Golf

Jetta (North America / China)

The Beetle (North America)

Passat GTE

Passat (China/North America)

Gran Santana (China)

Touran

Sharan

Santana (China)

Phideon (China)

T-Roc

Touareg

Tiguan

New cars presented at Geneva motor show in March 2019:
Concept ID Buggy Electric

New Passat

Volkswagen brand SWOT Analysis

Strengths

- Strong brand with very good quality image
- Strong technical competence
- Powerful toolkit infrastructure inside VW group including for conventional and alternatives power transmission
- Lead position in China
- Clear strategy for the future including for e-mobility and autonomous cars

Weaknesses

- Diesel issue mainly solved, but with a huge cost and some image degradation
- Position in North America now somewhat weakened

Opportunities

- Upside potential in core and developing markets
- Management and fighting spirit reinforced after the tough period following the diesel issue
- Possibility to strengthen again by absorbing other companies with the complementary restructuration that will occur in the automotive market
- Volkswagen can become the leader in electric cars with their targeted investments.

Threats

- Automotive market future more uncertain than ever
- Strong position in Europe and China challenged by competitors
- Huge challenge for the conversion to e-mobility and autonomous cars and risk for the sale of the very important quantity of electric cars prepared
- Competition with Google, Intel, Apple,... for the leadership in car systems.

VOLKSWAGEN LIGHTING

Introduction to Volkswagen Lighting

Eight decades lie between the first headlamps of the Beetle and the IQ.Light system of the Touareg. For Volkswagen the first priority is safety, so they are moving to apply the best lighting technologies on all their models following a democratisation strategy.

During our DVN visit, Ricardo Plöger (Manager of the Lighting and Vision department) and Mathias Thamm (Manager of Technologies and Innovation) and their team presented the main current products as well as their developments to prepare the future of lighting in Volkswagen, summarised by Chief Designer Klaus Bischoff:

"The light of the future is developing into a means of communication. It will interact with the driver and other road users—whether in a car, on a motorcycle or a bicycle—as well as pedestrians, thereby significantly improving safety. At the same time, we will integrate the lighting functions more progressively into the design of the vehicles than ever before."

Volkswagen Light Demonstrator

Organisation for Lighting Development and R&D

Volkswagen brand R&D organisation

In Wolfsburg, Volkswagen have an interesting organisation of exterior lighting development with the following disciplines:

- Virtual validation and testing
- Front lighting applications
- Rear lighting applications
- Technologies and innovation
- Interface between engineering and styling
- Electronics (software and hardware)
- Project management assuring the link between vehicle directors and lighting development

Ricardo Plöger is head of the department lighting and vision in Wolfsburg. Mathias Thamm oversees the Technologies and Innovation team, which impresses with the number and quality of the original innovations they are developing.

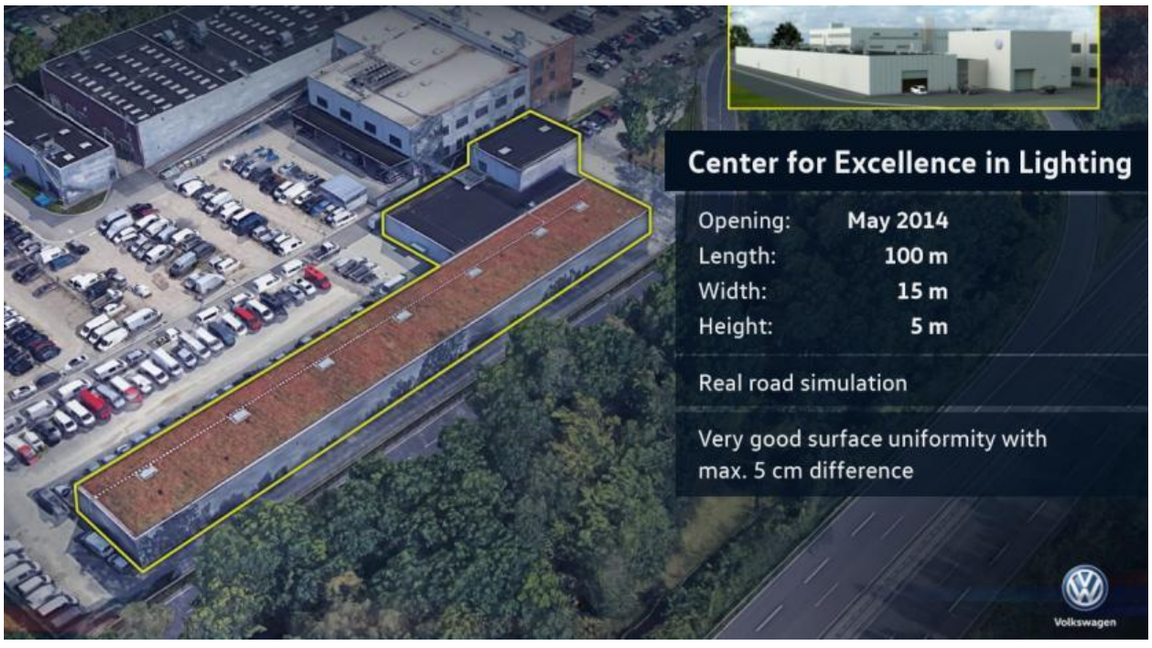
Lighting Facilities at Volkswagen Wolfsburg

Light Tunnel

VW have a new light tunnel 120 metres long (100m for validation), 15 wide, and five high. The floor has excellent flatness with only 5 cm difference between highest and lowest points, and has the same coating as current roads to facilitate accurate analysis of any light in a static consideration. A special screen at around 20 meters is used for presenting slides.

Light tunnel building

Aerial view



Tools and infrastructure

Volkswagen have all the needed tools for design and simulation. They are particularly using VRED for visualisation, Catia for design, Lucidshape and SPEOS for optical design and simulation—Speos, being more integrated in Catia, is interesting for some applications; Lucidshape is more practically linked to other VW-specific tools.

The simulation of the new functionalities offered by matrix ADB and later HD micro-pixels LEDs or matrix rearlamp is an important topic under development, but not yet used. For quality aspects and particularly condensation, temperature prediction, and PCB simulation, VW use ANSA for meshing, Fluent (ANSYS) for simulation, and Ensight for post-process. The condensation aspects are first simulated, but then tested particularly in China by the Volkswagen R&D team.

These tools are used by Volkswagen for their own pre-developments. For serial applications, many simulations are now done by suppliers. However, VW can help with their expertise and tools.

Lighting strategy

Volkswagen are striving for the democratisation of improved lighting features, extending LED front and rear lighting, and ADB in most VW-brand models to improve safety and fuel consumption and to have an appearance differentiation. They have a clear strategy to be pioneers and technical leaders for volume production with safer and smarter systems.

Development of safer and smarter technologies by being leader for volume production:

	Recent technology	Current new technology	Future technology
Front Lighting	Full LEDs →	Matrix ADB →	HD micropixel LEDs
Rear Lighting	Full LEDs →	Click-Clack →	Matrix rearlamp

Democratisation:
All these technologies that can be considered premium at the time of their introduction on the high-range models are then proliferated on all Volkswagen models including Golf and Polo through to the Passat. For instance, full LED headlamps will be generalised at least in Europe, China, and North America in the next three years. In parallel, their IQ technology with matrix ADB introduced in 2018 on the Touareg will be installed on other Volkswagen models, with a take rate of ADB targeted at 50%, much higher than the average in the world (Prediction of DVN: 25% in 2025). And during that time, the Volkswagen pre-development team are preparing the next generation with HD micropixel LEDs for front and matrix LEDs for rear in relation to the constraints of the next generation of autonomous, connected, and electric Volkswagen cars.

Volkswagen's Lighting story

Volkswagen have developed and commercialised many innovations consolidating their position of technological leader for volume production. The evolution of the emblematic Golf exemplifies the evolutions of style and techniques during these last decades for front lighting, with an improvement of light performance at each generation.

Evolution Golf I – VII Facelift - Golf I

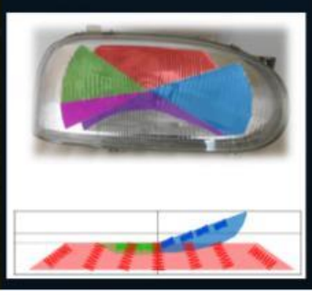
H4 Lamp for Low and High Beam

Evolution Golf I – VII Facelift - Golf II

H4 Lamp for Low and High Beam...
...2 mm bigger diameter ;-)

Evolution Golf I – VII Facelift - Golf III

H4 Lamp for Low and High Beam
Mulifocus Headlamp



Evolution Golf I – VII Facelift - Golf IV

First clear outer lens headlamp
H7 for low beam, H1 for high beam

Xenon headlamp also available

Evolution Golf I – VII Facelift - Golf V

H7 for low beam, H7 for high beam.

Due to huge diameter of reflectors, biggest light flux right now.

Evolution Golf I – VII Facelift - Golf VI

Optional Xenon Headlamp with dynamic bending light

Evolution Golf I – VII Facelift - Golf VII

Optional Xenon Headlamp with dynamic bending light and masked high beam

Evolution Golf I – VII Facelift - Golf VII Facelift

Optional LED Headlamp with dynamic bending light and masked high beam

Lighting track record - Milestone Innovations

Mathias Thamm and his team presented the rich history of innovations of Volkswagen lighting, particularly with:

• Window-clear headlamp lens on the Golf 4 showing the low beam, high beam, fog lamp, and turn signal—at its introduction a great styling differentiation with the arrival of complex-shaped reflectors replacing parabolas.

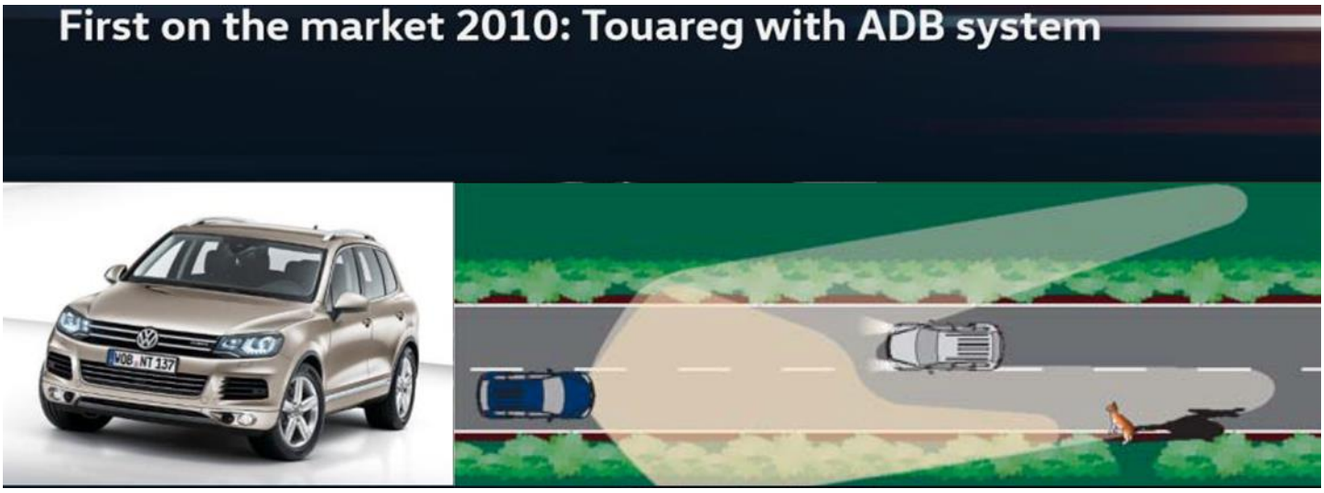
• First AFS with dynamic bending light in Passat B6 in 2005.

• First ADB with masked high beam and mechanical movement in the second generation Touareg models in 2010, the first iteration of the biggest innovation in lighting since the electric headlamp.

Golf 1997: VW's first clear-lens headlamp, with new challenges to achieve the level of quality requested by this direct visibility of all components from outside the car.

Phaeton 2001: First BiXenon headlamp Instead of having a moving shield as introduced later, the "bi-xenon" function was produced at that time by two Xenon modules in each headlamp, one for low beam and one for high beam.

2010 First ADB on the Touareg – "Dynamic Light Assist Systems"
These innovative ADB systems launched first in the world in 2010 by Volkswagen on the Touareg and the same year on the Phaeton had a mechanical system using a rotating shield moved by a stepper motor to produce low beam, high beam, and ADB with an HID lamp. In ADB mode, the left headlamp produces an L-shaped beam and the right one a symmetric shape, both being moved horizontally to follow the position of other cars. Volkswagen had a very strong-willed policy for the democratisation of this innovation going in three years from the premium cars Touareg and Phaeton to the Golf. Later was developed another generation of ADB still using a mechanical principle, but with LEDs replacing HID bulbs. Since 2018 with its introduction on Touareg, the ADB function is realised by a matrix system.

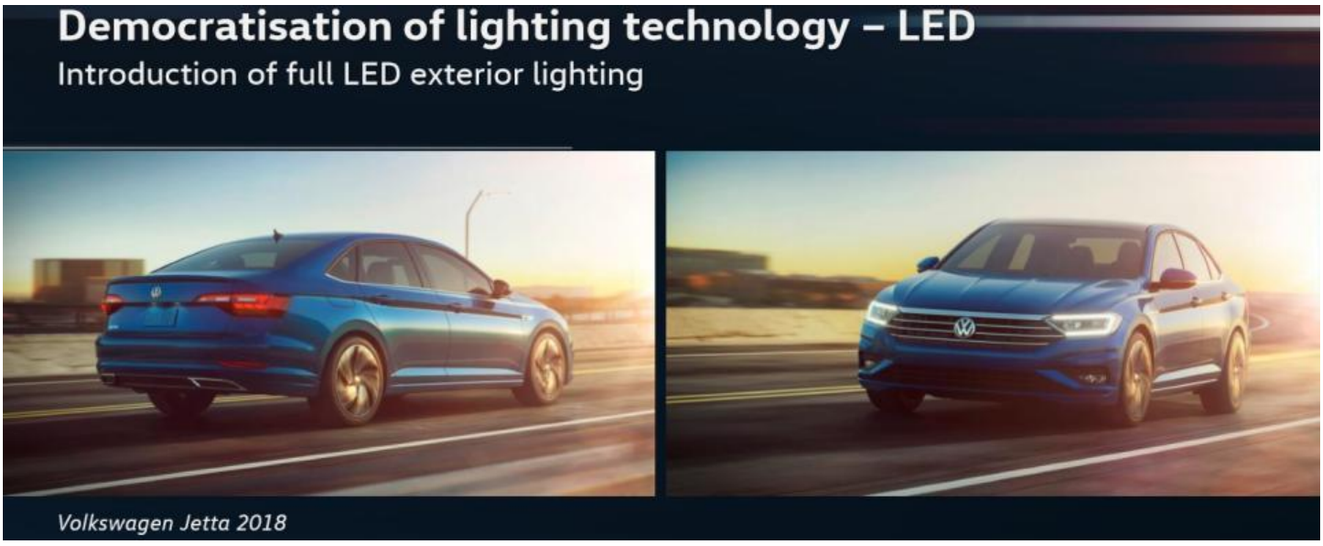


Democratisation of ADB- "Dynamic Light Assist" systems:
Volkswagen have pushed the ADB innovation to a large range of cars: the Golf in 2013 with an average take rate now of 30%, significantly higher than the worldwide average still under 15%. They are targeting a take rate of 50% before 2025 for this function for the cars equipped.

LEDs for front lighting

Volkswagen introduced halogen (H4) in 1974, HID in 1997, and LEDs in 2014. This relatively long time to adopt LEDs on front lighting illustrates the strategy of Volkswagen to improve performance permanently (i.e., once performance is upgraded in a particular aspect it does not backslide) and honestly, the first applications by others of LEDs for front lighting were less performant than HID. The 2014 Passat was one of the first LED headlamps to be clearly better than HID. Today, all models have LED headlamps at least as an option as for instance the Polo or the last small SUV T-Cross launched end 2018. The Volkswagen Jetta

launched in 2018 in America is the first Volkswagen car having all the lighting functions with LEDs. This direction will be extended as Volkswagen are targeting to have all models at least in Europe, North America, and Asia 100% equipped with low beam, high beam and DRL LEDs before 2022.



New Jetta for the American market

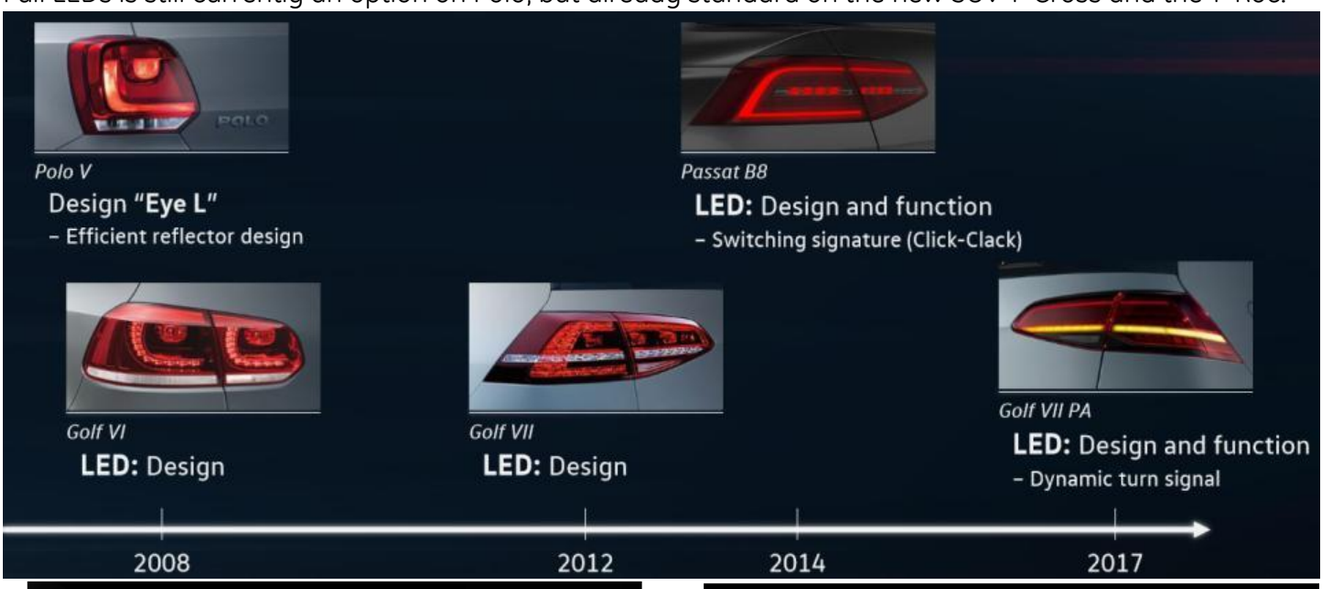
The new Jetta 2018 is equipped with full LED for the front and the rear as standard equipment. To have full LEDs on every car, a cost-effective technology with direct reflectors was developed achieving cost and performance competitive with halogen, with 500 lumens in the beam.

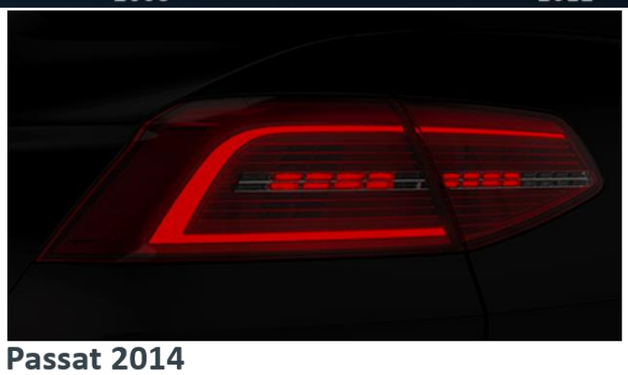
DRL

Low beam, high beam, DRL

Rear lamps: From Bulbs to LEDs for Increased Safety

First introduced in signal functions, LEDs for rear lighting functions are now used as a signature.
Full LEDs is still currently an option on Polo, but already standard on the new SUV T-Cross and the T-Roc.





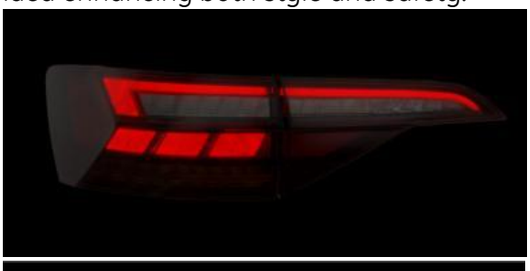
Passat 2014

Tiguan 2016

Golf 2017

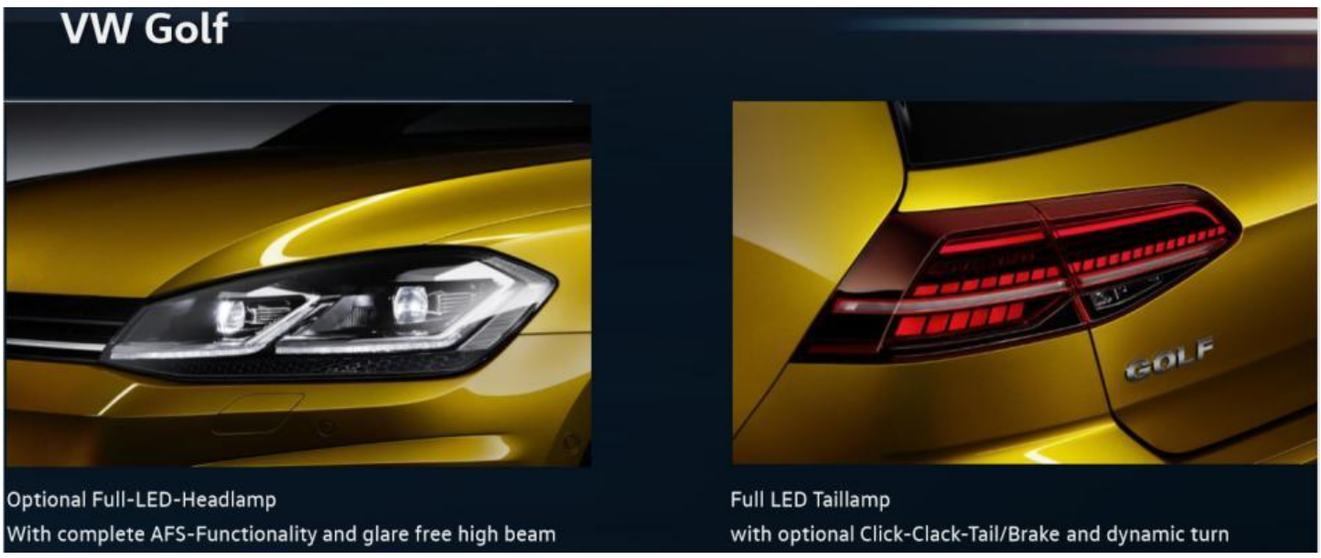
Touareg 2018

The "click-clack" feature is an interesting idea enhancing both style and safety.



Current VW Lights

Here are some examples of the technical directions of Volkswagen towards full LEDs both for front and rear, and towards "IQ Light" ADB for front and "Click-Clack" taillamps (changing lit shape for stop versus tail functions), the distinctive current Volkswagen premium technologies that will be available in the next years for all VW models.

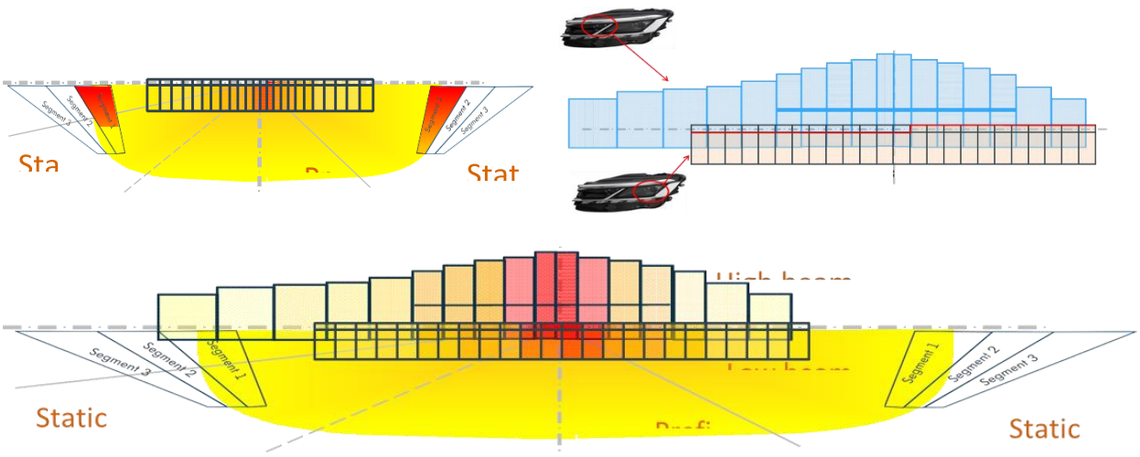


Touareg IQ.Light

On the exterior, Volkswagen premiered in 2018 their latest new Touareg. The new model features LED matrix headlamps developed together with Hella. The new lighting system is marketed under the name of "IQ.LIGHT Matrix Headlamps". In each headlamp, 128 LEDs are used for all lighting functions. The performance is particularly impressive, with 1,150 lm and 34,375 cd on low beam, and 2,150 lm and 131,250 cd on high beam.

The system has 13 adapted light distributions (e.g. for cities, country roads and highways) and particularly:
- Marking light with night vision
- Masked high beam
- Sequential turning light
- Adverse weather light
- Offroad light

At the bottom of the headlamp, five reflectors for the forefield low beam distribution (yellow in diagram below), and at the inboard part, three small lenses for bending light. The main beam is realised by a module with 27 LEDs (blue in the diagram) dedicated to high beam and a low and high beam pixel module with 48 LEDs.

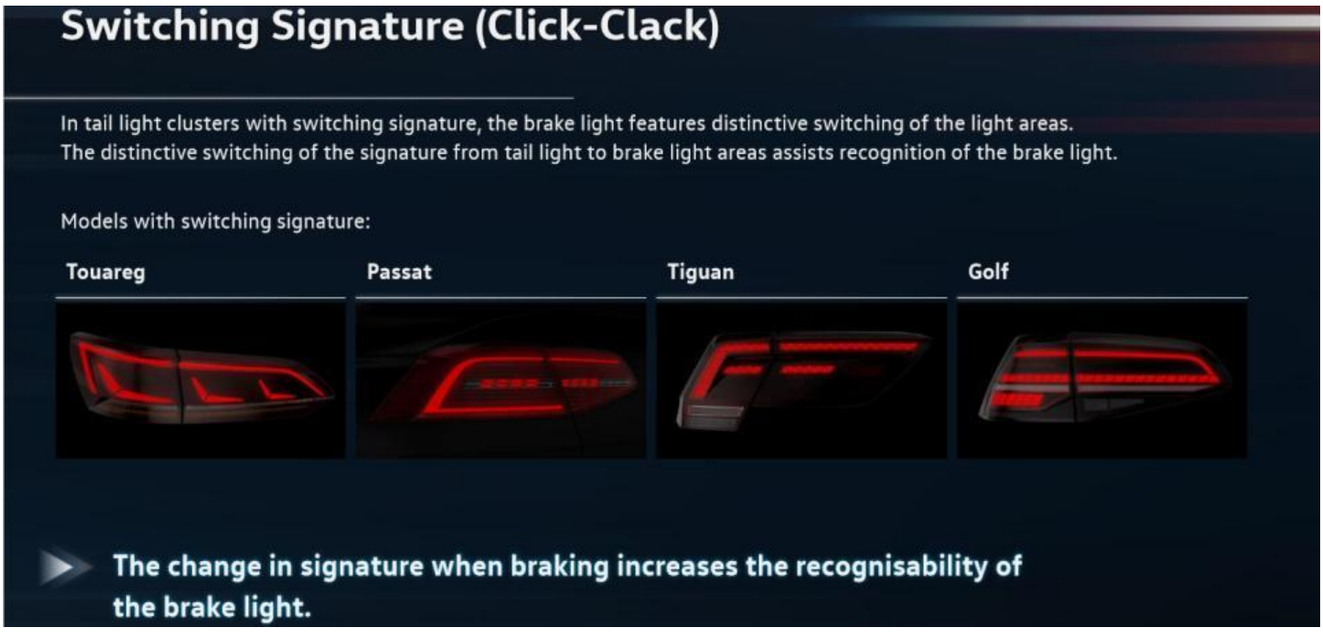


The five lower reflectors make the foreground illumination and the outboard module makes the low beam with ADB. Total light flux: 2,600 lm with a width of 60°L to 60°R. The static bending light allows an outstanding overall width of 90°L to 90°R. The adaptive matrix headlamp controls up to 128 LEDs to provide precise and optimal light distribution and luminous intensity. Individually-controlled LEDs blend into a matrix of light areas in both the high and low beam modules. The low beam employs a matrix of 48 LEDs positioned on a shared circuit board

DVN President Hector Fratty did a test at the launch of the vehicle in 2018 and had these comments: "The two first impressions after driving on low beam for a few minutes is the perfect homogeneity and a very large spread. This large spread is increased by the static bending light which gives a dynamic impression with the three lights lit on depending on the steering angle or activated turn indicator. The change from low to high beam is very pleasant, with the dynamic movement, like 'opening' the light. There's no distraction from dancing light in the ADB; it gives a smooth movement of light when cars arrive in the environment. Retroreflective road signs are effectively de-glared; they're lit up enough to be legible but not so much as to be dazzlingly bright. After analyzing on the roads, the latest models, the light of the Touareg is in the Top 3 with Mercedes E-class, and Audi A7"

Dynamic Rear Signature: Click-Clack

This "Click Clack" tail and stop light was introduced on 2014 Passat. The change of the signature increases the perceptibility of a braking manœuvre of the car ahead. This function addresses the accident rates of rear-end-collision and Volkswagen are progressively rolling out this technology into several segments and models.



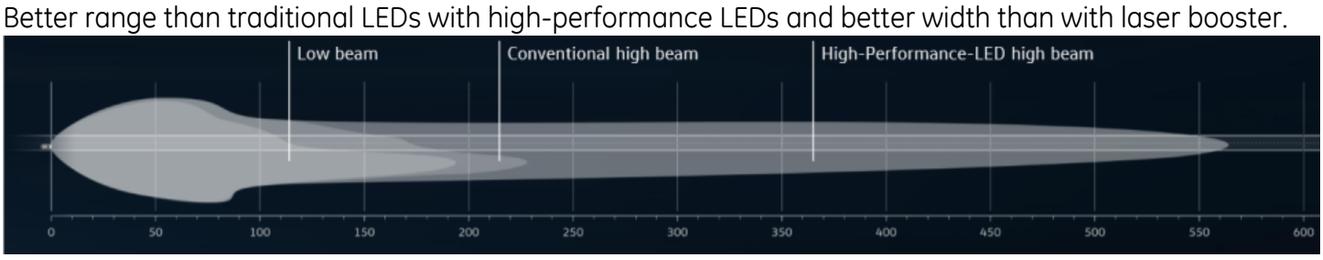
Lighting Innovations

Volkswagen put high priority on safety and are targeting very high performance systems. During our visit, we saw very interesting innovations in this direction.

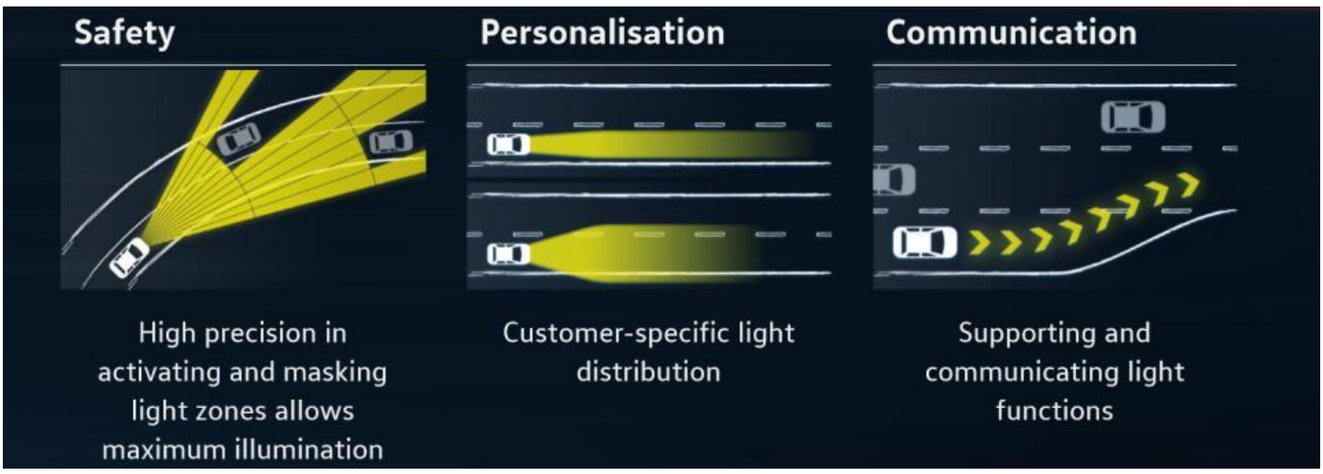
High Performance LED headlamp

For the improvement of range, Volkswagen looked at laser systems, but were not so enthusiastic on the technical constraints—particularly the thermal ones and the cost. They are now targeting a similar level of performance with the new generation of high-performance LEDs allowing a much-improved range while keeping a good width and allowing very slim modules.

Better range than traditional LEDs with high-performance LEDs and better width than with laser booster.

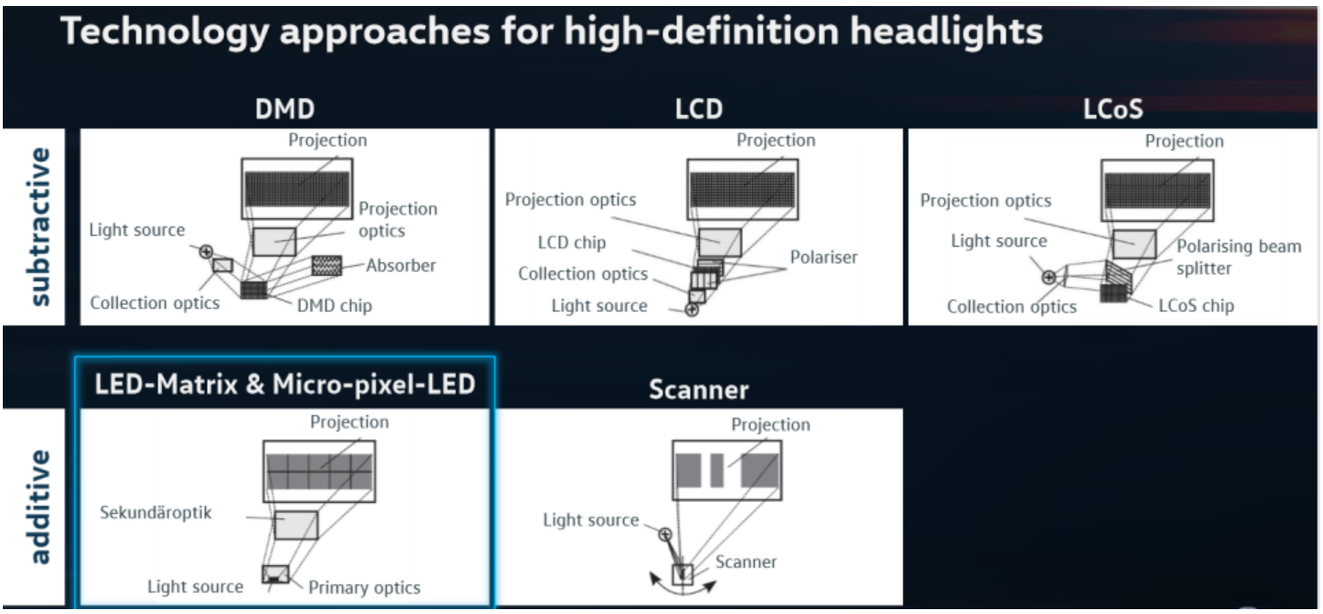


Headlights as a medium for communication: For Volkswagen, the future will be with smarter and smarter systems, with new functionalities and new communication abilities. The Volkswagen team are preparing several solutions in direction of this future.

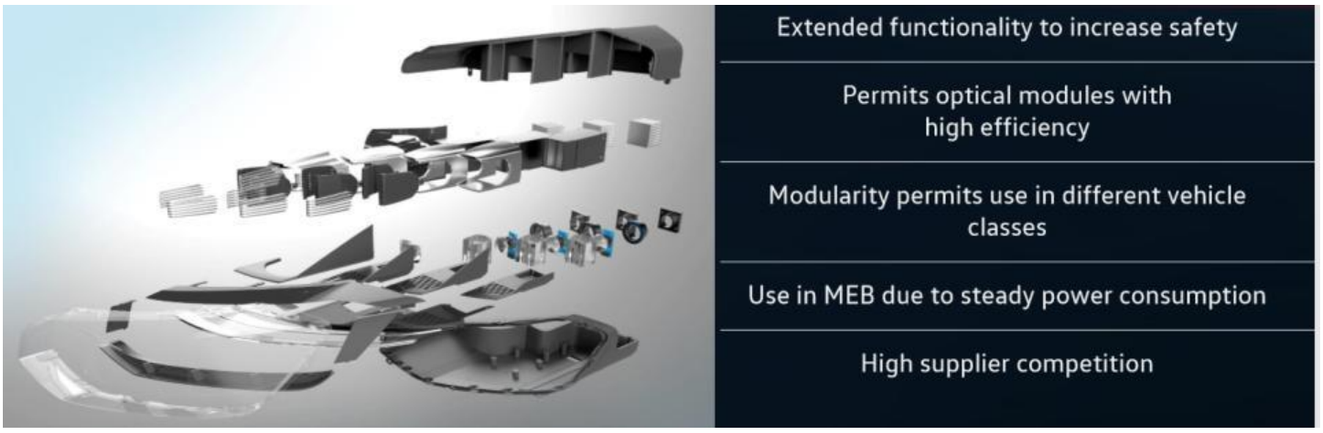


High definition headlights: To support these future communications with front lighting and for improved safety with improved functionalities, Volkswagen are looking at the best technology for high definition projection systems. They have analysed all the main technologies and have chosen to go forward with a micropixel LED technology. The main reasons are:

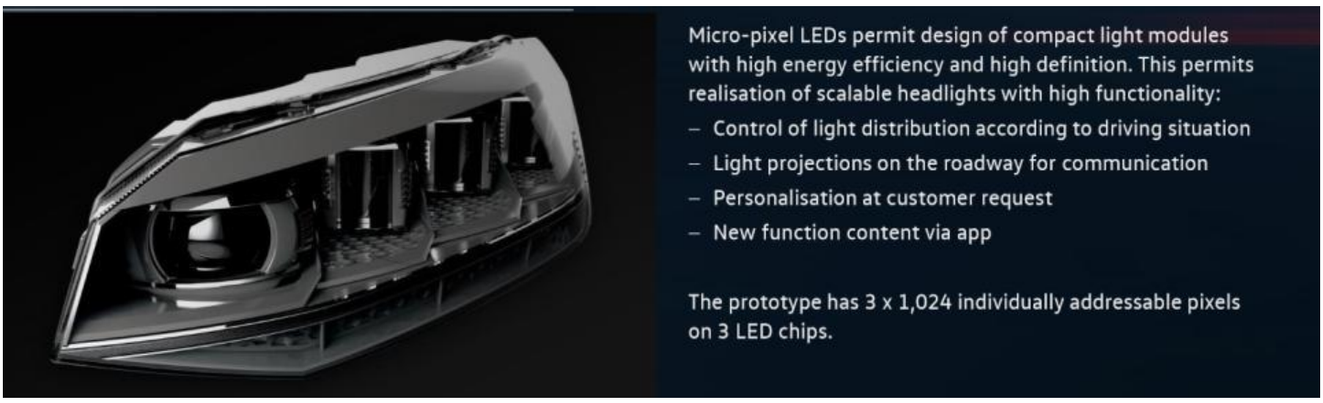
- Better efficiency, very important for electric vehicles (less than 60w required per lamp on high beam)
- Better maturity even if not yet validated with better modularisation and compact packaging.
- Multiple high-level suppliers for the chips



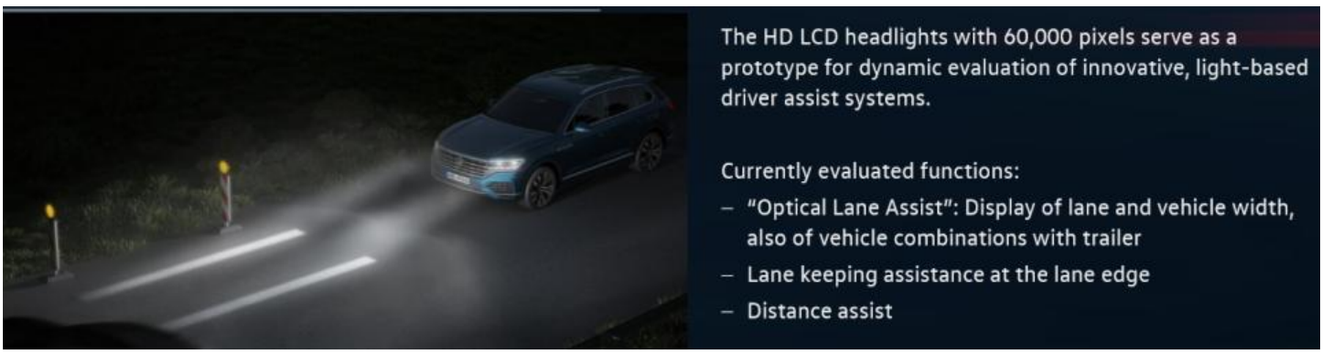
The benefits of this micropixel LED technology seen by Volkswagen are the following:



Volkswagen have made a prototype with three micropixel chips, each with 1,024 pixels.

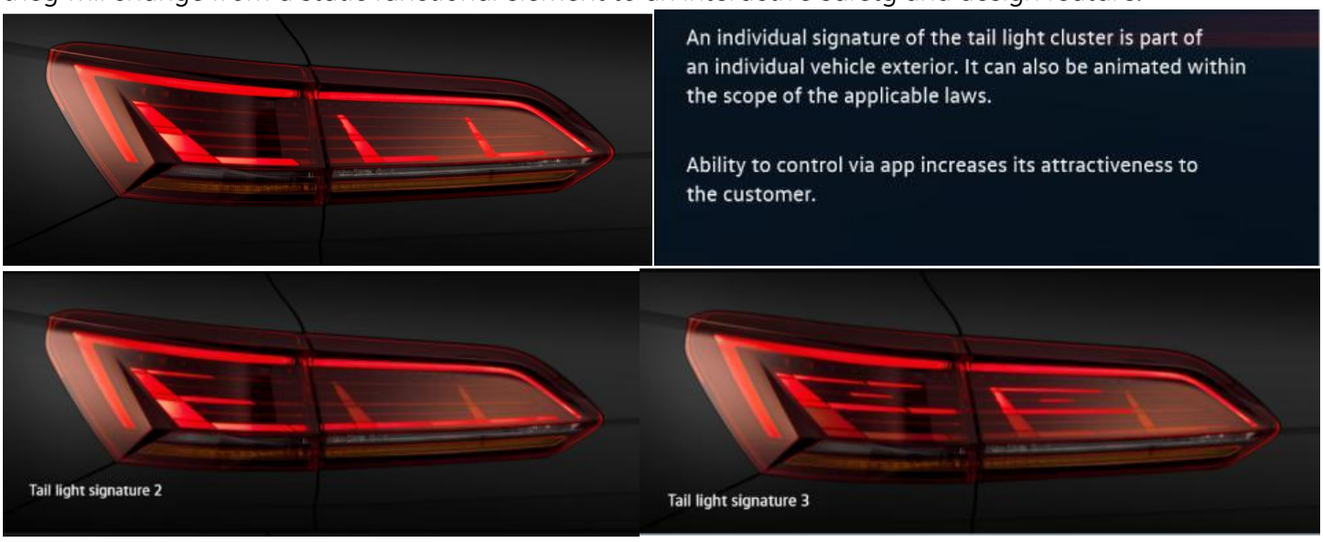


LCD: For evaluation of HD functions, Volkswagen have also made a prototype with LCD, but this technology is considered not mature enough for application soon, particularly regarding the insufficient efficiency on low beam.



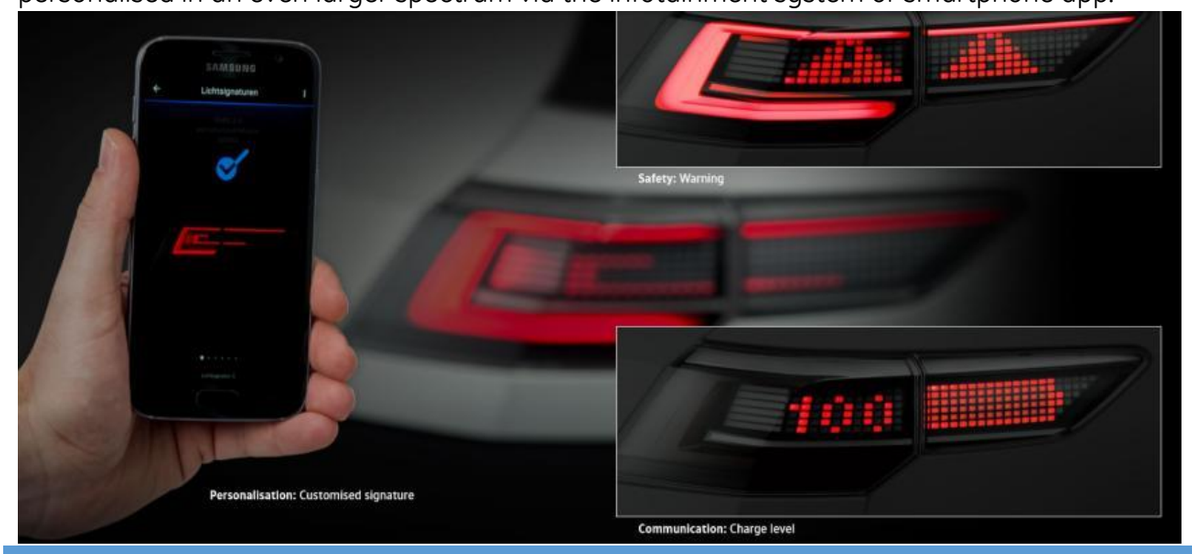
Customisable signature for rearlamps

For rear lamps, Volkswagen have developed solutions for the change of the signature. It will also be possible to link the signature to the respective driving mode. In the case of the Touareg, for example, as a "Comfort", "Sport", or "Off-road" selection. Light graphics will be an individualisation feature in the future—they will change from a static functional element to an interactive safety and design feature.



Matrix tail light cluster

Volkswagen have developed a very interesting matrix display in the tail light cluster that permits new, digitalised and individual displays in the tail light. It could be a very distinctive element and very helpful for communication when regulations will allow it. Like the customisable tail light, the matrix tail light also has a static signature in the exterior area for legal reasons. The interior is equipped with a matrix that can be personalised in an even larger spectrum via the infotainment system or smartphone app.



Optical Park Assist

for projection of the manoeuvring area that serves as a supporting light function for vehicles being parked manually or autonomously. Micro lens arrays are used for their realisation. This feature could be legal in white, but not in red. Volkswagen are scheduling it for future applications.

Tail Light Cluster Holography

This volume holography is a new vehicle lighting technology that permits innovative optical and design concept. The hologram is visible from different angles, so that a three-dimensional impression is created. Soon it could provide a completely new design and functional spectrum of tail lights. Volkswagen presented us their first prototype of this new generation of lighting functions using the holography with irradiation by a laser and storage on an exposed photopolymer. The target is to improve both safety and style.

I.D. Demonstrator

In order to optimally design, test and present future lighting functions, Volkswagen have developed a new, innovative working tool: the light demonstrator. This ID model allows the designers to project the light of the future into the present.

Interview with Ricardo Plöger

Manager, Lighting and Vision Department at Volkswagen AG

Ricardo Plöger was born in Munich in 1977. 10 months later his parents moved to Brazil, where he spent the first 20 years of his life. In 1998 he came back to Germany to study mechanical engineering at the Technical University of Darmstadt. After finishing his studies, he started his professional career at Volkswagen in 2004 as an international trainee. From 2005 to 2016 he had the opportunity to devote himself in several positions in the field of design of safety restraint systems, crash testing, safety electronics, building up a crash lab, simulation and aerodynamics. During this time, he also had the pleasure to work with different brands within the VW group and thus was able to enhance his international experience. Since 2016, he is responsible for the Lighting and Vision Department of Volkswagen.

DVN: What were in your company the main achievements concerning lighting in the past 10 years?

Ricardo Plöger: One of the main achievements during the last ten years was the democratisation of innovations with a strong added value. For instance ADB systems were first introduced on the market by Volkswagen in 2010 on the Touareg, then on the Passat and after on the Golf. Similarly, LEDs that were introduced on premium cars are now on all Volkswagen models—even on the Polo—at least as an option, giving the possibility to everybody to access the benefits for colour and longevity of LEDs.
And this democratisation will continue with the IQ-Light Matrix beam launched on the Touareg. This is a particularly powerful headlamp with more than 1,200 lm on low beam and an intelligent system with thirteen modes including a night vision system. This system is giving a strong improved safety, currently a reference on the market, and will be installed progressively on all the other models of Volkswagen, so that it will be available for every pocket.

For rear lamps, the same democratisation is on the way with the "Click-Clack" solution which is not only bringing an attractive style, but is also improving the safety thanks to the dynamic change of signature between tail and stop much better perceived.

DVN: What is your strategy about lighting for VW models?

RP: As mentioned before, the models that are coming now and in the near future will follow our full LED strategy. But lighting is evolving from a classic vision of functionalities to become a part of the driving assistance and communication system with new functions to be implemented. Since we shall have autonomous cars in the future, the question will be: how can we communicate with a heterogenous environment? We shall have autonomous cars, but we shall have also pedestrians, cyclists and manual driving cars. These other users will need to know what will happen. For example, when you are in a crossing, you normally look at the other driver to understand his intention. Similarly, autonomous cars will have to give understandable signs to the other users and for sure, lighting will get this new task. This a mid-long-term vision and we need to understand what kind of communication will be necessary.

We are today in the middle of the way having started this thinking, but we must do complementary studies to properly define these future communication tools. These new functionalities not only for driving assistance, but also for communication will be introduced between 2025 and 2030. Our predevelopment activities are preparing that. It is too a matter of legislation that must give a frame. We are optimistic for the technology itself that will bring not only ADB, but also improved driving assistance and communication all around the car even for the volume segment, thanks to modularisation and scaling effect. Our matrix rear lamp is a good example of what can be done, and I was impressed by the number of communications possible with this feature giving a lot of possibilities. This innovation is not only for styling even if for sure customers will love it, but it will give very useful information, for instance if it is slippery, if there is a traffic jam, if there are road works, and so on. We have identified several use-cases for this technology that is already technically available and can be introduced soon when the regulation will allow it. But first we need to know if these tools are useful, and if yes, we need an open door from the regulation. We strongly believe that lighting components are deeply related with safety. You have possibilities to enhance safety and therefore reduce the number of accidents when you allow the introduction of a better technology through a win-win work together with our governments.

DVN: What are your targets concerning the lighting sources, particularly for the replacement of halogen by LED for front lighting, and for the development of new sources like laser LEDs and OLEDs?

RP: In the next three years, all Volkswagen cars except in India and Latin America will have full LEDs for low beam, high beam and DRL functions. Turn indicator with LEDs will be generalised later. Currently, thanks to simplification of electronics, modularisation, and scaling effect, ***LEDs are competitive with halogen at a similar level of performance*** considering that some materials can be less expensive due to the reduction of the temperature. For entry level, we are targeting to have at least the level of performance of a good halogen headlamp. LEDs are particularly appreciated by customers for their light colour. Customers are feeling better with them as the colour is like what we have during daylight at the opposite of the yellow appearance of halogen. So we shall have for entry versions LED systems at least better that halogen, and for top versions, we shall have systems that should be the benchmark of the segment, with high performance and matrix ADB. Volkswagen is an important brand followed by our competitors, and we need to be the pioneer in the volume segment.

DVN: Volkswagen were first to introduce ADB in the market in 2010. Have you some feedback from customers for this function? Which take rate are you targeting in the future?

RP: Our ADB systems called Dynamic Light Assist have a good success with a take rate over 30%. For future applications, we are targeting a take rate of 50% both for entry versions and top versions in average. The take rate could be between 40% and 60% depending of models. We have very positive feedback from the press and no complaints from the market about this function. For the Touareg, we received very positive feedback from our quality department that is very demanding after their very intensive tests done everywhere in the world. We were also rated at the first place by ADAC, the independent safety organization in Germany We can also say that the bending light function is very appreciated by customers, and we intend to keep it.

DVN: About ADB technology, do you think that mechanical systems can continue to play a role? How do you see the future of ADB technologies including high definition systems?

RP: In the future, matrix will be the lone technology for Dynamic Light Assist. However, we shall continue to have a hybrid situation with a swiveling mechanical system for the bending light function for some models. For high definition systems, we looked to several technologies including LCD, DLP, LCOS, laser scanning and Micropixel LEDs. For the next applications, Micropixel LED solutions will have the first role with the best balance contrast and cost. This technology has a better flexibility, a better power efficiency and a competition is existing between the three to four high level suppliers of the chips that is not the case for some other technologies. We are discussing directly with these tier two suppliers about our own requirements and they are really listening to our demands et designing the chips in a proper way so that we can implement them.

One important question is the number of pixels requested. For projection of signs, one thousand pixels is not enough, and twenty-five thousand pixels could be necessary for that. For only ADB, one hundred pixels could be enough. We need first to define which functionality is useful with a clear added value. So even if Micro-pixels LEDs is not today fully validated, it is our plan A and we think it will be the technology that will come first. And we have a plan B by looking at the other technologies mentioned before. And later, this future technology as the current ADB Matrix will follow our top/down democratization strategy by being also implemented on Golf and Polo cars.

DVN: The main directions for the evolution of car industry will be towards more electric, more autonomous and more connected cars. How do you see the consequences for lighting?

RP: Light is going to be smarter and smarter. Intelligence of lighting systems needs to increase a lot. We have to prepare a car-to-X communication and the light will be one of the tools for this communication with the environment. So, you need to invest a lot not only in the component development itself, but also in the infrastructure of the platform, and put intelligence on the electronics and algorithms particularly with autonomous cars that are coming. This intelligence will be implemented on each platform in the Volkswagen group and the headlamps will have to be connected so that we can stir them properly. This intelligence will be implemented in our embedded high-power computers. We need to define the interface and communication protocols with the headlamp. The development of this central software is our job. This software will be harmonised inside the Volkswagen group, prepared by common working groups, with decision per platform and model for application, and available for all the Volkswagen group.

DVN: Do you feel that future lighting systems will integrate sensors as cameras, lidars, and others?

RP: For the technical point of view, I would say yes. But what I learnt so far is that these kinds of sensors are very sensitive to the change of environment. Therefore, it is still necessary to study what kind of changes we can do to implement them properly. Lamps are not today only a technical component, but also a styling component that can lead to some technical constraints. What we can do or not is also a matter of strategy. If these sensors can be robust enough to the changes, lamps could be an excellent place for some of them. Currently, we have not decided yet.

DVN: Cost is also an important driver and we have seen during the last years a strong evolution towards more sophisticated products with in parallel increase of costs: have you some targets and means in relation to product cost?

RP: This evolution is stopped since two-three years. During that time, we have increased the technology and decreased the price. So, we have a huge enhancement of functionalities with a much lower cost. Perhaps we are today in lucky days, but more surely the team did a very good job by defining a good concept, while modularisation, simplification of electronics, standardisation with reduction of options and scaling effect helped for cost decrease. This can be achieved as we have a previous reference and everything can be better in this following generation. When we have a totally new pioneering concept with a lot of validation to do, we need to achieve a kind a maturity before achieving the best prices. These new concepts would be for instance micropixel LEDs for headlamps and matrix systems for rear lamps. For this last function, it will be a totally new electronics system with a LIN or CAN bus and a new intelligence on board. The technology is today available, but we need an adaptation of the regulation to introduce this concept and we believe that China could be the first to adapt it as the government is working to simplify the regulation. When the engine is not on, we shall have more communication and more functionalities, and when the regulation will be released, we shall have the frame to start the tests.

DVN: How do you see regulations going on? What do you propose to improve?

RP: Simplification and harmonisation are the two topics addressed currently by the GTB working groups. It is a good direction fully supported by Volkswagen. We think that the GTB working groups are doing fantastic work and I thank them for their work. The current regulation is based on functionalities introduced in the fifties. Now we see a high-speed evolution of functionalities that can enhance safety and that are calling for a legislation. The driver assistance and the projections that we can implement on the headlamp, the communications that we can implement on the rearlamps are points that we can discuss for an adapted regulation. My petition would be to have an open ear from the government in this direction to have the opportunity to push this kind of technologies on the market. The industry is putting a lot of effort in pre-development and we are wishing that a discussion for a new regulation would open soon.

DVN: How do you see Lighting in 10 years?

RP: The evolution of lighting is clear: smarter and smarter. We will have driver assistance over there and at least communication that we have not today. So, we shall have much more functionalities. Not only an adapted regulation will be necessary, but we shall need also a huge increase of electronics competences. The lighting industry is very good at the traditional techniques like optical, thermal, etc, but we need to increase hardware and software competences for these developments as a lot of intelligence will be integrated in the platform and the infrastructure. For autonomous vehicles, we shall have different kinds of sensors implemented, based on different physical principles. Some of these sensors as cameras are requiring a good lighting at night with a good range and a good width. And even if we have no driver, we need to see the environment and to identify what is happening. So, lighting will still have a big future.

DVN: You are coming from the safety domain: what is motivating you with lighting?

RP: What impressed me is the passion from the persons involved in the lighting family especially here in Volkswagen. It is amazing to see how people are working hard with full dedication, full passion. This makes me very happy, very optimistic, and this is also opening a promising future. It is not only a question to have the good technology, it is also important to have the right people with a good motivation to develop the best products because at the end of the day, the output is driven by persons. An important point is to bring value to customers, and we have the chance with lighting to have a product with a lot of appeal.

Conclusion

Lighting at Volkswagen appears strong with a clear strategy and a good team. This strategy to be the technical leader in the volume segment and to democratise new technologies quickly to all models was repeated several times and is obviously applied. The latest 2018 Touareg, for instance, with a sophisticated and powerful matrix beam including 128 LEDs per headlamp is at the level of the best premium products. And the willingness to have full LEDs front lighting in the next three years for all models at least in Europe, North America, and Asia, and to have the ADB function installed at 50% in the next years in Volkswagen brand is demonstrating the good application of the democratisation principle.

Volkswagen also are preparing for the future with several interesting technologies including high definition ADB or Matrix rearlamp. We have every reason to think Volkswagen will continue to keep their position in the future, offering the best technologies to a maximum number of people.

Recent official VW Brand News

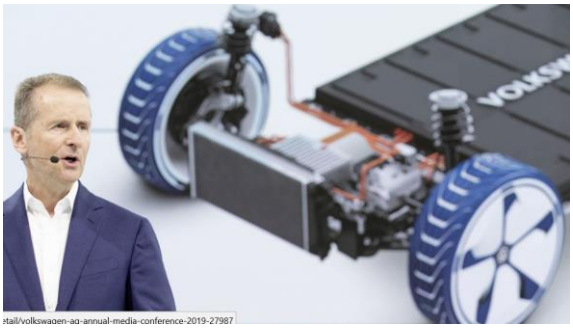
2019 March 19th: VW Brand China, FAW-VW in New Connected-Services JV

Volkswagen Brand China and its Chinese joint venture FAW-Volkswagen are scaling up their coöperation in the area of digitalisation and connectivity: MOS Intelligent Connectivity Technology will be established in Chengdu. The partners are investing a total of RMB 1bn (€131.5m, $149m) in the company that will operate under the MOSI brand, for Mobile Online Services Intelligent. The objective is to develop and offer digital services for all future VW models of FAW-VW from 2019 onwards, including vehicles based on the modular electric toolkit (MEB) from 2020.

2019 March 12th: VW Group Brands Deliver Solid Performance

In fiscal year 2018, the Volkswagen Group again benefited from their broad positioning and the sustained solid performance of their brands and their financial services. Dr. Herbert Diess, Chairman of the Board of Management of Volkswagen AG, says "2018 was a successful year for the Volkswagen Group. We performed very well in spite of strong headwinds. Our Group brands worked very hard to help achieve this result. We must now redouble our efforts, step up the pace and resolutely continue the transformation we have begun." The Volkswagen Passenger Cars brand continued its product initiative in 2018, growing its sales revenue by 6.8 per cent to €84.6bn. Operating profit before special items amounted to €3.2 (3.3) billion. The increase in vehicle sales and improved product costs had a positive effect. Higher sales expenses resulting from factors such as the environmental bonus, exchange rate effects and upfront expenditures for new products, especially in connection with the implementation of the electric mobility campaign, weighed on the operating profit. In addition, the WLTP test procedure presented challenges. The operating return on sales before special items was 3.8 (4.2) per cent. The diesel issue gave rise to special items of -€1.9 (–2.8) billion.

2019 March 12th: VW Plan 22m EVs in 10 years



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The Volkswagen Group are moving ahead with the fundamental change of system in individual mobility and systematically aligning with electric drives.
The Group are planning to launch almost 70 new electric models in the next ten years, instead of the 50 previously planned. As a result, the projected number of vehicles to be built on the Group's electric platforms in the next decade will increase from 15 million to 22 million. Expanding e-mobility is an important building block on the road to a CO_2-neutral balance. Volkswagen have signed off a comprehensive decarbonisation program aimed at achieving a fully CO_2-neutral balance in all areas from fleet to production to administration by 2050. Volkswagen are thus fully committed to the Paris climate targets.

2019 January 28th: Great Comeback in Brazil

With investments in excess of €2bn by 2020, Volkswagen do Brasil starts to recover market share.

2019 January 28th: Yesterday an Engine Plant, Today an E-Pioneer

The Salzgitter plant is getting ready for electric drives. While one of the 86 production lines is still used for building heavy six-cylinder engines, among other things, the workers next door are making a fist-sized electric pump.

2019 January 23rd: Five Millionth Tiguan!

The Tiguan celebrates a historical production anniversary: in just eleven years, five million vehicles of the compact SUV series rolled off the assembly line. Almost 800,000 units were sold in 2018.

2019 January 15th: VW, Ford Embark on Alliance

Volkswagen CEO Dr. Herbert Diess and Ford CEO Jim Hackett confirmed that the companies intend to develop commercial vans and medium-sized pickups for global markets beginning as early as 2022. The alliance will drive significant scale and efficiencies and enable both companies to share investments in vehicle architectures that deliver distinct capabilities and technologies.

2019 January 11th: Record Sales in 2018

With 10.83 million vehicles delivered throughout the world, 0.9 percent more than in 2017, the Volkswagen Group set an all-time record. In many markets of the world, South America, Europe, the USA and China, both the deliveries and in some cases the market shares of the Volkswagen Group grew. With successful product offensives, the Group brands were able to more than compensate for the risks in individual regions such as the general economic uncertainty in China and the adverse effects of the WLTP changeover in Europe. Especially the Group's new SUV models were strong growth drivers. The Volkswagen Passenger Cars, Škoda, Seat, Porsche and Lamborghini brands all set new deliveries records. Dr. Christian Dahlheim, Head of Volkswagen Group Sales: "Even though setting new records is no longer our primary goal, we are very pleased about this great result. Especially in the second half, things were not easy for us in 2018. It was possible to achieve this new deliveries record for the Group thanks to a combination of outstanding products and the high level of trust placed in us by our customers. In view of volatile geopolitical developments, our business will face an equally strong headwind in 2019.

2019, January 1st: New Volkswagen Group Components Brand

Since January 1, 2019, the Volkswagen Group have had a new brand. With the realignment of

Volkswagen Group Components, the Group are reinforcing their in-house supplier of components including engines, gearboxes, electric drive systems, steering systems and seats, while consistently leveraging synergy effects. 80,000 Group employees at 61 plants throughout the world develop and produce vehicle components. Right from the start, the units will therefore be among the world's largest automotive industry suppliers.

2018 December 6th : VW Brand Speeds Operating return

The Volkswagen brand is to significantly improve its earnings performance in the coming years in order to finance investments in future technologies from its own resources. The model portfolio is being streamlined and the number of variants reduced. Productivity at the plants is to be increased and the platform orientation for vehicle production extended. Optimising material costs is to contribute significantly to achieving the target return without detracting from product substance. Administration processes will become even leaner. "We must force the pace of our transformation and become more efficient and agile. We cannot let up in our efforts and must realise further substantial improvements. What we have achieved so far is still not enough," said Ralf Brandstätter, the brand's Chief Operating Officer responsible for day-to-day business. In total, the Volkswagen brand will be investing over €11bn in e-mobility, digitalisation, autonomous driving, and mobility services from 2019 to 2023, of which over €9bn will be spent on Volkswagen's electrification efforts. The brand currently has two fully-electric cars in its range. This number will increase to around 20 by 2025, with planned production set at over one million units. Work on converting the Zwickau plant to be run exclusively as an electric mobility site is already underway, and in addition the plants in Emden and Hanover will switch to the production of electric vehicles from 2022. Collectively, these three sites will become Europe's largest e-production network. Two electric vehicle plants are also currently taking shape in Anting and Foshan in China, with production scheduled to commence in 2020. For North America, the brand plans to make a decision on a production location for electric vehicles soon.

With the fully-electric ID made in Zwickau, where the order process features pre-booking for the first time, Volkswagen is putting a new generation of vehicles on the road that also sets standards in digitalization and connectivity. "With the ID., the dawning of the e-mobility era and connectivity for our brand becomes tangible for our customers, too. The ID. will be the first fully-connected, fully-electric car and will be a symbol of the 'New Volkswagen'", Board Member for Sales Jürgen Stackmann said.

Volkswagen will also be investing strongly in digitalization. The Volkswagen Automotive Cloud developed together with partners lays the groundwork for offering an ever-growing range of digital services in fully-connected vehicles. The aim is to create the world's largest automotive ecosystem.

In order to finance the enormous future investments, the Volkswagen brand will have to realise even higher cost savings than previously planned. "We have therefore defined a bundle of measures to

improve profitability that will safeguard the full implementation of the pact for the future while also supplementing the topics of the pact and setting the right course for 2025," CFO Dr. Arno Antlitz explained.
The pact for the future will realise cost savings amounting to more than €2.2bn by the end of 2018. That means most of the planned total savings of €3bn by 2020 will already have been achieved. Further massive savings are expected from measures such as the strong expansion of the platform model. Currently, approximately 60 percent of the conventional models are based on the Modular Transverse Toolkit (MQB), and this is set to increase to around 80 percent by 2020. Volkswagen have already built over 50 million vehicles based on the MQB, and the Group are projecting a similar volume for the coming years. As many as 15 million Group vehicles based on the MEB are to leave the assembly line under the first wave of electric models from 2019.
Another lever is plant productivity, where an average increase of 30 percent is planned for the period to 2025. At the same time there is to be a massive reduction in the complexity of the model portfolio. In Europe, the brand will be discontinuing 25 percent of the engine-transmission variants with low customer demand in the coming model year, with corresponding positive effects on the complexity of production and the supply chain. These and further measures such as optimizing material costs should contribute towards boosting the operating return more swiftly than originally planned. "We are confident that we will be able to reach our target of an operating return of at least 6 percent in 2022, three years earlier than originally planned," Antlitz said.

2018 November 30th:

Volkswagen ID. R is Race Car of Year...Twice!

An all-time record at the legendary hill climb on Pike's Peak with a pioneering, fully-electric drivetrain, done by the Volkswagen ID. R Pikes Peak. The 500-kW (680 horsepower) prototype sports car has now been crowned Race Car of the Year twice—by specialist German magazine Auto Bild Motorsport and by British car magazine BBC Top Gear. This recognition from two renowned and high-circulation magazines follows a year of success on the track.

2018 November 28th:

Beetle Final Edition

The Beetle, along with the the New Beetle, is a true icon in the history of automobile manufacture. Volkswagen celebrated the last production year of the Beetle and Beetle Cabriolet with the "Final Edition" special models presented at the Los Angeles Auto Show in November-December 2018.

2018 November 19th:

30 Million VW Brand Deliveries in China

Volkswagen are revving up in China, reënergising the brand under their Move Forward initiative. The brand's product portfolio was strengthened with nine new models in 2018. The 30 millionth Volkswagen—a Touareg—was delivered to a customer in China.

2018 November 16th:

Investing in the Future

The Volkswagen Group are investing heavily in their future. Through to the end of 2023, the company will be spending almost €44bn on the future issues of e-mobility, autonomous driving, new mobility services, and digitalisation in their vehicles and plants. This represents approximately one-third of total expenditure for the 2019-2023 planning period, and is the outcome of the Group's planning round, which has now been completed.

2018 November 5th:

Smart Traffic Management With Quantum Computers

The Volkswagen Group are making further progress with work on quantum computers. For the first time, Volkswagen experts have succeeded in using a quantum computer to develop a traffic management system that will replace forecasting for urban traffic volumes, transport demand and travel times with precise calculations. As a result, public transportation organisations, taxi companies, and transport service providers will be able to deploy their fleets considerably more efficiently while minimising wait times for passengers. Volkswagen and quantum computing company D-Wave are presenting the project at the WebSummit technology conference in Lisbon.

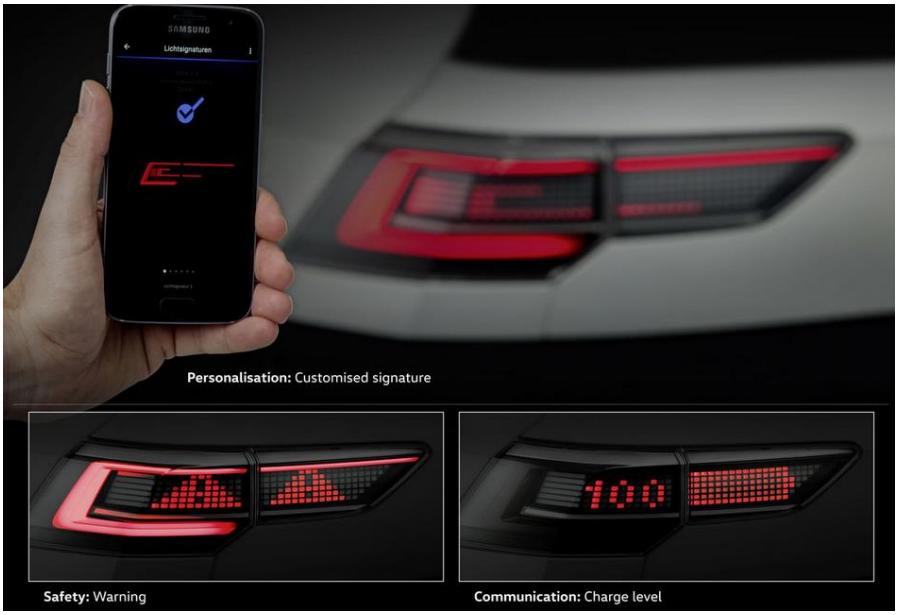
2018 October 29th:

VW, Mobileye, Champion in Israel's 1st AV-EV Ride-Hail Service

The Volkswagen Group, Mobileye, and Champion Motors will deploy Israel's first self-driving ride hailing service—or Mobility-as-a-Service (MaaS)—starting next year. Operating as "New Mobility in Israel," the group's proposal was formally accepted by the Israeli government during a private ceremony at the Smart Mobility Summit 2018 in Tel Aviv.

2018 October 10th:

Interactive Lights Raise the Bar for Safety in Future



Innovative Volkswagen lighting technology is helping to boost safety. At the same time, it is also opening the door to increasingly personalised vehicle design. At an international workshop, Volkswagen showed how the lighting systems of the future will communicate and increase safety even further.

Volkswagen's engineers and designers use all of the technology available to them to improve safety with innovative lighting technology. One of their goals is to enhance the lighting functions in current vehicles and, as a result, improve road safety in the present day. This development work has culminated in the IQ. Light matrix LED headlights in the new Touareg, for example, which improve comfort and safety when driving at night. However, lighting designers and engineers have an eye on the future, too. The assisted driving cars of tomorrow will confront road users with new everyday situations, such as a lack of eye contact with drivers.

This is where new, interactive lighting functions come into play. The new lighting systems will include micropixel HD headlights with up to 30,000 light points and high-performance LED headlights as a low-cost alternative to cost-intensive laser light. For the first time, these micropixel HD headlights will project information directly onto the road, further improving safety.

This technology also enables new assist systems such as "Optical Lane Assist" to be brought to life. In this system, the headlights project lanes in front of the Touareg, giving the driver precise information about the width of the SUV (including trailer) and the distance to the road lane markings, for example at road works. The lanes also follow the radii of curves. Such useful and safety-enhancing lighting functions are being tested with the HD-LCD headlights.

Interactive tail light clusters for added safety

New systems such as the matrix tail light cluster will also revolutionise tail lights. Matrix tail light clusters will allow warnings to be incorporated into the tail lights, for example, enabling dangerous situations, like the area at the end of a traffic jam, to be defused using car-to-car communication. New assist functions, such as the micro-lens-based "Optical Park Assist" system, will improve safety while manœuvring. This system will be able to project the vehicle's path onto the road to alert passers-by to the parking process.

In-house Volkswagen light tunnel reduces development times

To make sure they are suitably prepared for the challenges of the future, Volkswagen have opened their own centre of lighting excellence at the Wolfsburg plant. A 120-metre-long, 15-metre-wide, five-metre-high light tunnel is crucial to VW's lighting R&D activities. Tests can be reproduced and repeated; systems can be compared and evaluated in a light tunnel better than ever before. The centre of lighting excellence is also an ideal place to investigate how drivers and pedestrians perceive light. The light tunnel has also reduced the development time for new headlight, tail light and interior lighting systems, as the number of time-consuming night drives can now be reduced. Progress in light development can thus be implemented even more quickly into series production technology, increasing safety for the benefit of all road users.

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