Record-racer ID.R
Pioneer of the ID. family

As of 03/2021

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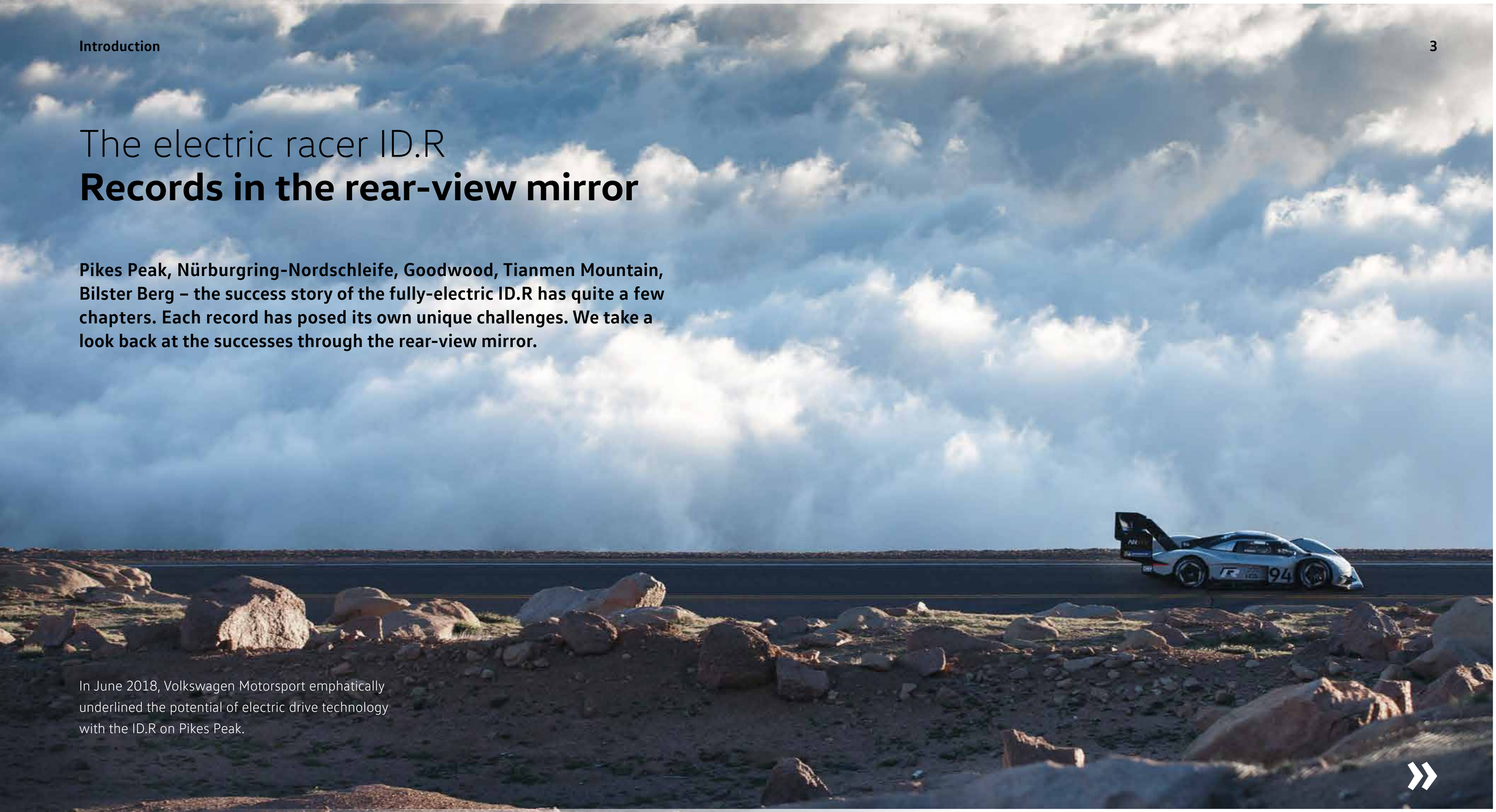
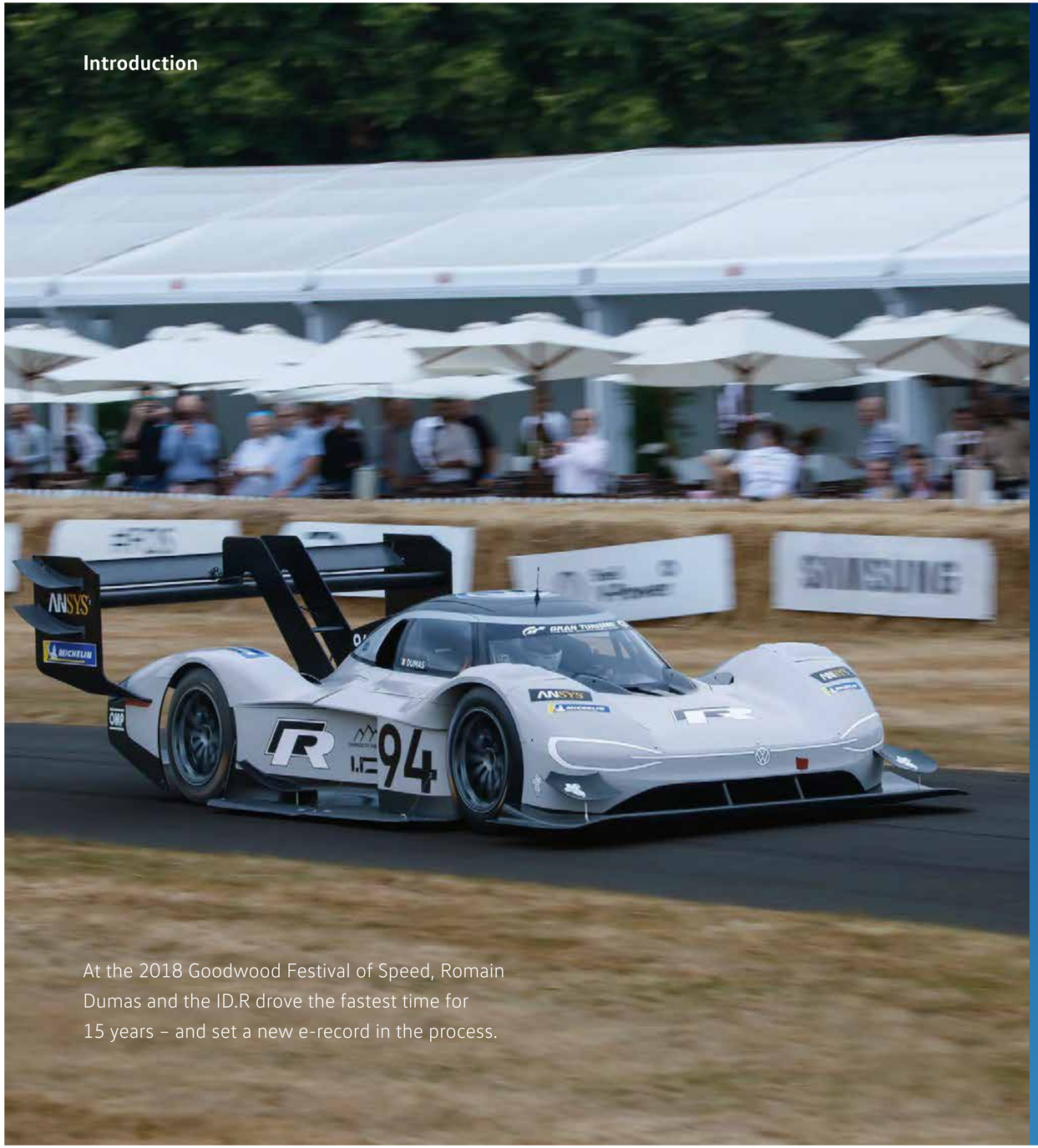
June 2019: Romain Dumas and the fully-electric ID.R set a new lap record for electric cars on the legendary Nürburgring-Nordschleife.

The electric racer ID.R
Records in the rear-view mirror

Pikes Peak, Nürburgring-Nordschleife, Goodwood, Tianmen Mountain, Bilster Berg – the success story of the fully-electric ID.R has quite a few chapters. Each record has posed its own unique challenges. We take a look back at the successes through the rear-view mirror.



In June 2018, Volkswagen Motorsport emphatically underlined the potential of electric drive technology with the ID.R on Pikes Peak.



At the 2018 Goodwood Festival of Speed, Romain Dumas and the ID.R drove the fastest time for 15 years – and set a new e-record in the process.

Six records on three continents in 815 days. These are the impressive figures for the Volkswagen ID.R. After being developed in just 250 days, Volkswagen's first fully-electric race car was ready to go. But how? On 24 June 2018, Volkswagen Motorsport wrote the first chapter of this success story – followed by five other impressive performances. But first things first.

Pikes Peak: Electric drive beats combustion engine

In setting the all-time record at the Pikes Peak International Hill Climb in June 2018, Volkswagen Motorsport ensured that people sat up and took notice of one of the most ambitious projects in its history of more than 50 years. "There was no precursor to the ID.R race car, we literally started with a blank sheet of paper," said François-Xavier Demaison, Technical Director of Volkswagen Motorsport, recalling the start of the project in October 2017.

Just 250 days later, on 24 June 2018, Romain Dumas completed the 19.99-kilometre route up Pikes Peak, in the US state of Colorado, in a time of 7:57.148 minutes. In doing so, he smashed the previous record, held by Sébastien Loeb, by more than 16 seconds. The Frenchman had climbed "America's Mountain" in a 643-kW (875-PS) Peugeot 208 T16 with a combustion engine in 2013. Five years later, compatriot Dumas achieved something unique in the electric ID.R: never before in the history of the hill climb, which dates back to 1906, had a driver reached the summit at 4,302 metres above sea level in under eight minutes.

Goodwood 2018: The fastest time for 15 years

The next record followed just a few weeks later. On 15 July 2018, at the Goodwood Festival of Speed in England, Dumas and the ID.R set a new record for electric cars with a time of 43.86 seconds – and took overall victory in the process. His best time was also the fastest for 15 years and the third fastest of all time on this short but demanding route.

Evolutionary version for the Nordschleife

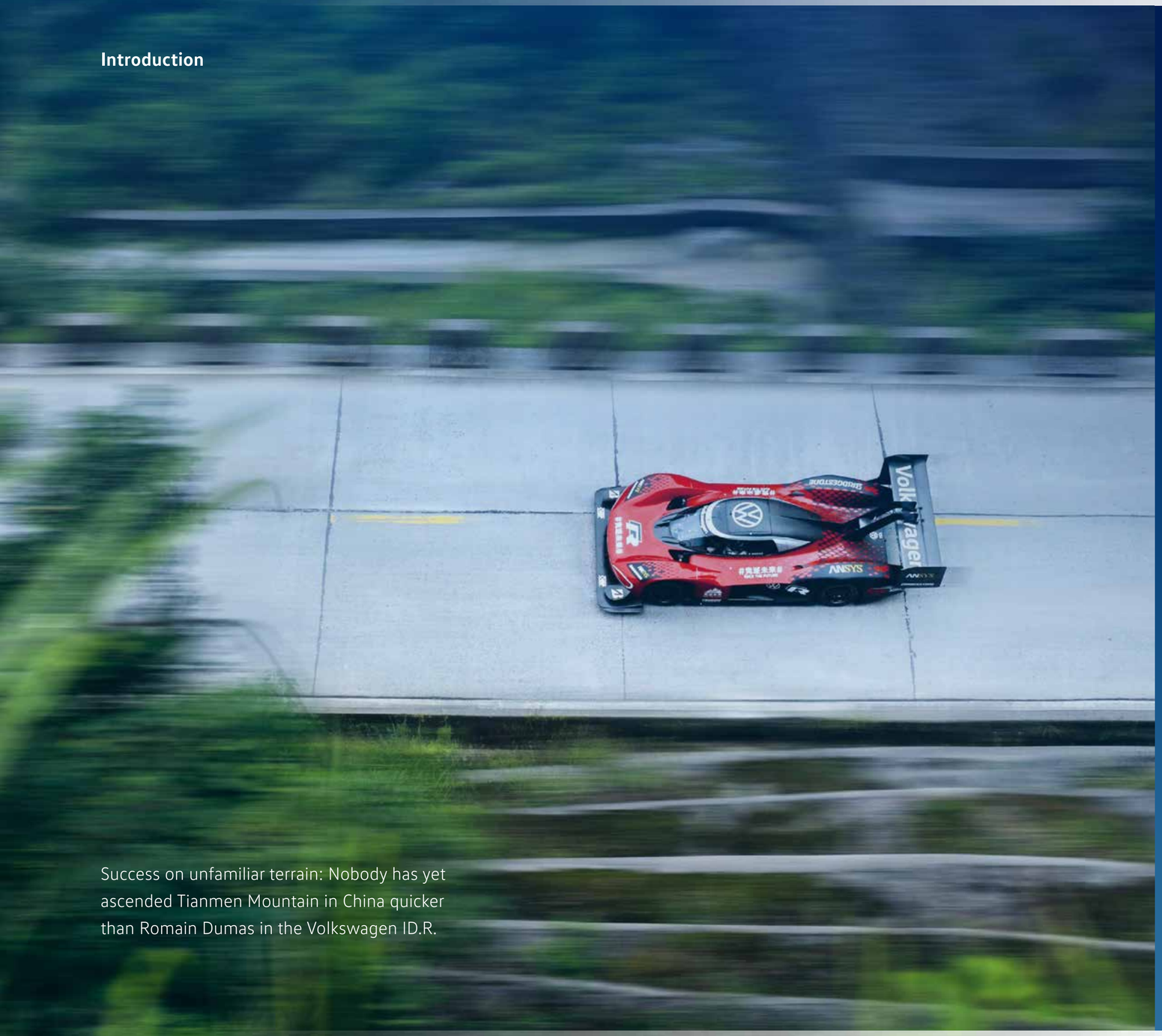
On 03 June 2019, Dumas set the fastest lap by an electric race car on the Nürburgring-Nord-

schleife. At the steering wheel of the ID.R the Frenchman lapped the 20.8-kilometre circuit in a staggering time of 6:05.336 minutes. Dumas beat the previous record, set by Peter Dumbreck in a NIO EP9 in 2017, by a massive 40.564 seconds. With an average speed of 204.96 km/h, the ID.R once again underlined the performance of Volkswagen's electric drivetrain.

For Dumas, who has won the 24-hour race at the Nürburgring four times in the past, the record-breaking drive with the ID.R was another highlight on his favourite track. "I am incredibly proud to be a record-holder on the Nordschleife," said Dumas. "For me, it is the best and most difficult racetrack in the world. I would like to say a big thank you to the Volkswagen Motorsport team, who once again did a fantastic job. The ID.R was perfectly prepared for the Nordschleife. It was just great fun to experience the immense acceleration and high cornering speeds."

Following the record-breaking runs on Pikes Peak and in Goodwood, Volkswagen Motorsport comprehensively further developed the ID.R for the challenges it would face on the Nürburgring-Nordschleife within just five months. "With the evolutionary version of the ID.R, the aerody-

Success for Volkswagen Motorsport: the ID.R set a new Electric Lap Record at the Nürburgringring-Nordschleife and beat the previous by more than 40 seconds.



Success on unfamiliar terrain: Nobody has yet ascended Tianmen Mountain in China quicker than Romain Dumas in the Volkswagen ID.R.

namics are configured more for top speed than maximum downforce," explained François-Xavier Demaison. "Extensive tests in the simulator and on the racetrack allowed us to adapt the ID.R to the unique conditions of the Nordschleife. Above all, this affected the chassis set-up, energy management and optimal tyre selection for the record attempt."

This reduction in aerodynamic drag allowed the ID.R to hit top speed with less energy consumption on the long straights.

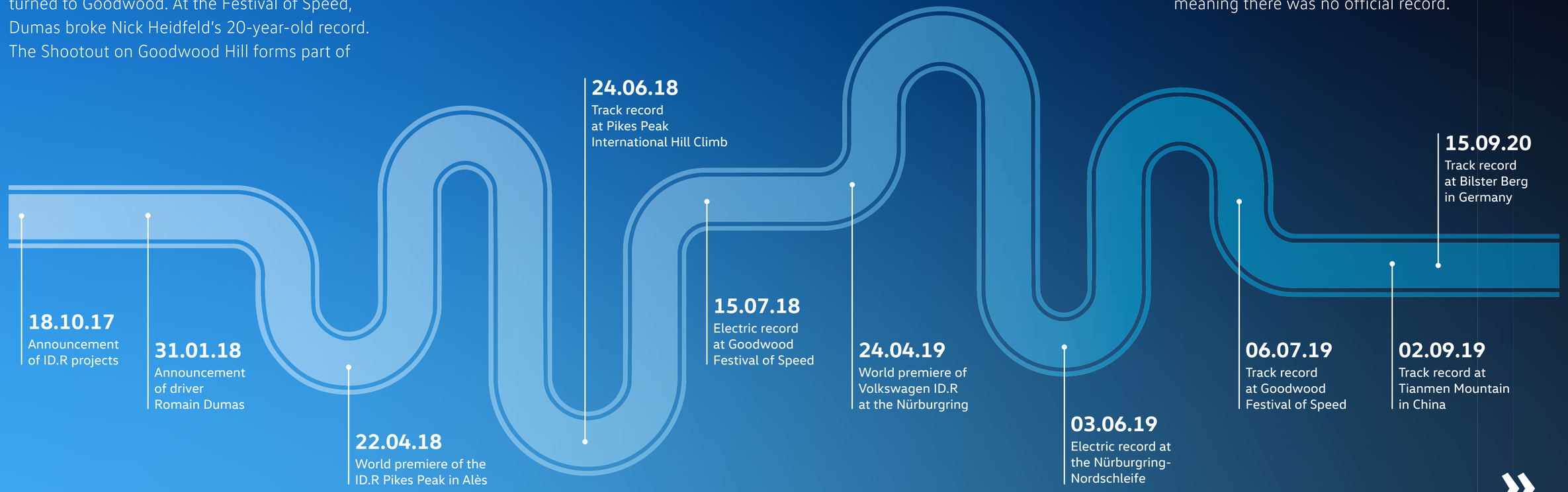
François-Xavier Demaison,
Technical Director Volkswagen Motorsport

The differences between the route of the hill climb on Pikes Peak and the iconic circuit in the Eifel Mountains represented the real challenge for the engineers and technicians. The high altitude on Pikes Peak meant the air was an average of 35 percent thinner than at sea level. The ensuring 35 percent loss in downforce was offset by the rear wing. On the Nordschleife, which winds its way through the Eifel region at

a maximum altitude of 617 metres above sea level, top speed plays a crucial role. For this reason, the ID.R was equipped with a drag reduction system (DRS), similar to those used in Formula 1. "This reduction in aerodynamic drag allowed the ID.R to hit top speed with less energy consumption on the long straights.

Goodwood 2019: New record in England
Four weeks later, Volkswagen Motorsport returned to Goodwood. At the Festival of Speed, Dumas broke Nick Heidfeld's 20-year-old record. The Shootout on Goodwood Hill forms part of the Festival of Speed and is a real test for driver and technology, with standing starts and a surface that is often dirty. The ID.R was once again modified for its title defence in 2019: changes to the battery management and the downsizing of the lithium-ion batteries used increased efficiency without compromising weight or power output on the 1.86-kilometre route. Dumas broke Heidfeld's existing record by 1.7 seconds on 06 July 2019. Back in 1999, the German had set a fabulous time in a McLaren MP4/13 from Formula 1. Two decades later, Dumas and the ID.R took their place in the record books with a new best time of 39.90 seconds.

Tianmen Mountain: A different kind of record
Early in September, the ID.R embarked on a voyage to the Middle Kingdom. According to Chinese folklore, Tianmen Mountain, located roughly 1,300 kilometres as the crow flies from the capital Beijing, forms the link between heaven and earth. The so-called "Heaven's Gate" is a natural, 7,000-m² natural arch in the mountain. One of the most spectacular roads in the world winds its way up to this gateway to heaven. It climbs roughly 1,100 metres via 99 hairpin bends. Never before had a car with the potential of the ID.R ascended the road, meaning there was no official record.



September 2020: Dieter Depping breaks the previous lap record at Bilster Berg by more than nine seconds.

Volkswagen Motorsport's goal with the ID.R: to climb the mountain pass as quickly as possible and set a benchmark for race cars on the 10.906-kilometre road. Dumas and the ID.R took on this spectacular challenge with enhanced aerodynamics, based on those used for the record-breaking run on Pikes Peak. Major changes were also made to the chassis set-up, as much of the road is made of concrete slabs with demanding transverse joints. A number of sections are asphalted, whilst others have a loose surface. This puts both driver and chassis to the test and is more reminiscent of a Rallycross circuit than a racetrack.

Preparations were not easy for the Volkswagen Motorsport engineers and Dumas: "The record attempt on Tianmen Mountain in China was a very special challenge from a technical and sporting perspective," said François-Xavier Demaison. "Nowadays, it is everyday practise to call on very precise data to perform detailed simulations, sort out the car set-up, and give the driver the opportunity to learn the layout of the route. This was not the case on Tianmen Mountain."

As the engineers did not have any usable data, they had to embark on a different path: at the start of 2019, they drove the 11-kilometre route several times. The data they gained, together with information on the condition of the road, formed the basis for an abstract 3D model, which was used to determine the key parameters. In particularly demanding places – such as turn 88, which is very tight with a radius of roughly six metres – the engineers even turned to a simple tape measure, in order to acquire precise values for the demands to be placed on the car. And with great success: on 02 September 2019, Dumas and the ID.R completed the route in 7:38.585 minutes.

Bilster Berg: Depping breaks the lap record

Record number six came at the Bilster Berg racetrack on 15 September 2020: during a test day, Dieter Depping completed a lap of the 4.2-kilometre circuit in a record time of 1:24.206 minutes. The Volkswagen test and development driver smashed the previous record, set in 2016 by Sven Barth (Step-1 MiKar C301B prototype), by more than nine seconds.

Motorsport as a laboratory
Technical pioneer ID.R

The Volkswagen ID.R served as a rolling laboratory and technology platform for the entire model range of the fully-electric ID. family. The experience gained and data acquired during the record-breaking runs were incorporated in the production development.

The fully-electric Volkswagen ID.R, the sporty figurehead of Volkswagen's electric offensive, and the link to the production models in the ID. family is closer than one might think at first glance. The 500 kW (680 PS) electric race car served as a technology platform for Volkswagen's electric production models.

"The cooperation between Volkswagen Motorsport and production development is a good example of efficient knowledge transfer," says Sven Smeets, Volkswagen Motorsport Director. "When we started the ID.R project in 2017, and had to have the car ready in just nine months, we benefitted from the support of the Research & Development department. In the

Energy management and aerodynamics: the production vehicles in the ID. family benefit from the knowledge acquired during record attempts with the ID.R.

The goal is the same in motorsport as it is in production – maximum efficiency. The way this is achieved can be different, as illustrated by DRS on the ID.R.

meantime, we have been given a lot back, including our knowledge of battery and energy management. The ID.R was a rolling laboratory for Research & Development."

Focus on maximum efficiency

The continuous further development of the ID.R benefitted more than just the Motorsport department at Volkswagen. The experience gained and data acquired during the tests and record-breaking drives are incorporated in the production development of the electric vehicles in the ID. family. Whether a record-breaking drive on Pikes Peak (USA) with the ID.R, or a journey down country roads with the ID.4[1], the main goal is the same: maximum efficiency from the whole car.

Much of the efficiency of the car as a whole is determined by its aerodynamics. In the case of extreme race cars like the ID.R, the aerodynamic drag is used intelligently to generate more downforce on the whole car. This is how the record-breaker was able to corner so quickly.

Aerodynamics play an important role

What makes the ID.R so special is its variable aerodynamic concept, which makes it possible to reduce aerodynamic drag in steps – during the drive, at the push of a button. This technology is also used in Formula 1 and is termed the Drag Reduction System (DRS). Unlike in the pinnacle of motorsport, the ID.R did not use DRS for overtaking, but to conserve energy.

In the case of the ID.3[2], you are not working with variable aerodynamic systems, but the basic goal for the production development department is still similar: maximum efficiency for long ranges. At speeds as low as approx. 50 km/h, aerodynamic drag is already the strongest resistance the car must overcome. As is also the case in motorsport, soft transitions alternate with clearly-defined trailing edges. The goal is for the air to flow along close to the car, and for the airflow then to break away cleanly – a design that looks as if shaped by the wind itself.

[1] Power consumption in kWh/100 km: 16.9–16.2 (combined); CO_2 emissions in g/km: 0; efficiency class: A+

[2] Power consumption in kWh/100 km: 15.4–14.5 (combined); CO_2 emissions in g/km: 0; efficiency class: A+

The "Sanya" rims on the ID.3 (left) and the ID.R (right) play an important role in the cars' aerodynamics.

Production rim design

The aerodynamic knowledge gained in motorsport flowed directly into the upcoming vehicles in the ID. family: Volkswagen Motorsport engineers helped their colleagues in production development to make future models even more aerodynamically efficient. This knowledge transfer not only had a positive effect on perfomance, but is also visible – for example, in the rims. The aerodynamically-optimised "Sanya" rims remain a distinguishing feature of the ID. family to this date.

This design was also used in the ID.R, although some of the demands placed on a motorsport rim differ from those placed on a production rim. For example, the supply of cooling air. However, there are a lot of things in common: "During the tests in the wind tunnel, we discovered that the c_W value improves if you cover the rims with an aero lip from the outside in," says Dr. Hervé Dechipre, the engineer responsible for the aerodynamics of the ID.R. "This improves the airflow around the wheelhouses, thus reducing aerodynamic drag and consumption. This is absolutely comparable with production."

Less cooling air and resistance

The thermodynamic control of the drivetrain and traction battery using cooling ducts is also key to achieving a high degree of efficiency. This basic rule not only applies to the ID.R, but also the electric production models.

The fronts of the ID.R (above) and ID.4[1] (below) give a uniform appearance.

Generally speaking, the electric race car coped with far less cooling air than race cars with conventional drivetrains. Just like the production models in the ID. family: they also do without the typical radiator grille and, with their flat front, present a uniform appearance.

The architecture of the drivetrain concept behind the ID.R, with two electric motors and four-wheel drive, will very soon be found in the initial production models within the ID. family. As such, there are already visible parallels when assembling the drivetrain. It is even more important to ensure that the heat balance

[1] Power consumption (NEDC) in kWh/100 km: 16.9–16.2 (combined); CO_2 emissions in g/km: 0; efficiency class: A+.

Pioneering work in motorsport, fine-tuning in production: the ID.R and ID.3[1] are related.

[1] Power consumption in kWh/100 km: 15.4–14.5 (combined); CO_2 emissions in g/km: 0; efficiency class: A+

– particularly the traction battery – is always kept in the optimal window.

Performance battery in the design stage
With electric vehicles, the focus of the Volkswagen engineers and thermodynamics experts is on controlling the temperature of the traction battery and cooling the power electronics and e-motor – not on efficiently extracting heat, as is the case with combustion engines. In the case of the ID.R, simulations were used prior to the test drives and record-attempts to analyse how the battery will react in certain conditions – particularly in different load scenarios, not least when using recuperation. "We adapted the size, and thus the capacity, of the battery to suit each new challenge and track," says François-Xavier Demaison, Technical Director at Volkswagen Motorsport.

In production, the models in the ID. family are available with different battery configurations, in order to meet the differing demands of the customer – for example, when it comes to power and range. A particularly high-performance battery for Volkswagen's electric production vehicles is already in the designing process.

High relevance of ID.R outings
The cooperation between Volkswagen Motorsport and the specialist electromobility departments at Volkswagen did not stop there:
The knowledge we have acquired with the ID.R, whether it be in simulations, physical tests or at the record-breaking drives on three continents, is very interesting to many departments at Volkswagen," says Demaison. "Data gathered on battery cells, cellular chemistry, different charge levels and power outputs are of great relevance to production development."

As a technological platform the ID.R has done pioneering work for the ID. family: driven to the limit, tested to physical limits – in order to use the findings in road cars.

Innovation leader ID.R
Extremely adaptable

Volkswagen is forging ahead with the topic of electric mobility. The sporty figurehead of this offensive is the fully-electric ID.R. The development has been continued consistently.

With its ID.R, Volkswagen Motorsport now holds five records on three continents to date[1]. The requirements for the 500 kW (680 PS) strong electric race car could hardly be more different. But the ID.R is adaptable. Thanks to its flexible technical layout, it is perfectly set up for new challenges. One of its success factors was the consistent development process of the ID.R by the engineers at Volkswagen Motorsport.

Why an e-engine is not simply an e-engine
The ID.R is equipped with two electric motors, whereby the limited space at the front of the car

[1] As of 03/2021

Consistent development on the ID.R since the project has started back in 2017.

means the motor on the front axle is slightly smaller than the one that drives the rear axle.

But is every e-motor identical? Of course not: as with conventional drive technology, there are design differences here too. “With electric motors, you generally differentiate between asynchronous engines and synchronous engines,” explains Johannes Brandt von Fackh, Team Leader Engine Testing at Volkswagen Motorsport. “In the ID.R, only permanently-excited synchronous engines are used. They have the advantage of having a higher power and torque density. In other words, they can generate more power. Asynchronous engines are easier to assemble and cheaper to manufacture. One of the reasons for this is that no rare earths are required and they are easier to control. However, this type of e-motor is less efficient.”

Electric motor tuning – a complex interaction

As with a combustion engine, various measures can be taken to increase the performance of an electric drivetrain. “The batteries can only hold a limited amount of energy. The temperature also plays a crucial role. After all, it is all about optimising the complex interaction between many factors, in order to achieve maximum performance and stability. This is obviously only possible to a certain degree, as the output of e-motors is also limited – and we have already exhausted that with the ID.R,” explains Brandt von Fackh.

Simulations speeded up development

An optimisation of this kind would not be possible without simulations. With the pressure on, the team led by Dr. Benjamin Ahrenholz, Head of Calculation/Simulation at Volkswagen Motorsport, has played a significant role in the preparations. “We used simulations in several areas in order to continue developing the ID.R. We saved a lot of time this way. The computer performance required for the many calculations was so high that we received support from the Volkswagen Production Development depart-

The permanently-excited synchronous motor in the ID.R is highly efficient and offers a high power and torque density.

Dynamic aero: The sophisticated aerodynamic features of the ID.R include the drag reduction system (DRS) on the rear wing, as also seen in Formula 1.

ment in Wolfsburg. If necessary, we could call on their computer network with several hundred processors," says Ahrenholz.

For example, when designing optimised chassis components, structure simulation was used to calculate the loads that the chassis of the ID.R would have to cope with on the Nordschleife. The driving dynamics simulation allowed Romain Dumas to practise and find the optimum strategy for managing battery power. At the same time, the computer also completed virtual laps of the Nordschleife in order to test the effects of various different set-ups, such as energy management.

Before the further developed ID.R was subjected to the airflows in the wind tunnel, the aerodynamic simulation had already calculated the effects of dozens of different wings, spoilers and flaps. The battery simulation was primarily used to research different energy management strategies, which control the power output and charging during the drive (regeneration). "For an engineer, the nice thing about the challenges on

Formula 1 technology in the ID.R

Without DRS (drag reduction system) activated, the ID.R generates roughly twice as much downforce as a Formula 1 car. Activating DRS reduces aerodynamic drag by about 20 percent. Compared to the record-breaking outing on Pikes Peak in 2018, the aerodynamic drag generated by the ID.R without DRS activated is roughly 33 percent lower.

the Nürburgring-Nordschleife, in Goodwood and on Tianmen Mountain is that we are given completely free rein. We can develop the most efficient solutions without being restricted by regulations," says Willy Rampf, technical consultant to the Volkswagen Motorsport team.

Variable aerodynamics with DRS

The basis of the ID.R remained unchanged in 2019. The first evolution of the Pikes Peak winner was also powered by two electric motors with a system performance of 500 kW (680 PS). The drive concept, with one electric motor per axle, and the lithium-ion batteries in the ID.R are comparable with the technology used in the fully-electric production vehicles of the ID. family.

In order to reduce aerodynamic drag, the ID.R was given a modified underbody and a front spoiler tailored to high speeds. The most distinctive feature was the modified rear wing. It is significantly flatter than it was for the first record-breaking run in June 2018. However, as higher downforce is required in the slower of the 73 corners on the Nürburgring-Nordschleife, the rear wing also uses technology that has become a familiar feature in Formula 1 – a drag reduction system (DRS). "Switches on the steering wheel allow the driver to change the setting of the main elements of the rear wing," explains Dr. Hervé Dechipre, the engineer responsible for the aerodynamics of the ID.R. Steeply-angled airflow control areas help generate greater downforce at lower speeds, while a flat wing reduces aerodynamic drag on the straights. "The difference in downforce is about 20 percent," says Dechipre.

Unlike in Formula 1, where the primary goal of DRS is to make overtaking easier, the system helped the ID.R manage the energy stored in its batteries more efficiently on its record-breaking lap of the Nordschleife. The adjustable rear wing allowed the ID.R to achieve its top speed using less energy. Furthermore, less energy was required to maintain the maximum speed on certain sectors of the circuit.

Software key to success

In order to achieve this, the software in the ID.R was completely re-programmed. "We practically started from scratch again with the energy management," says Marc-Christian Bertram, Head of Electrics and Electronics at Volkswagen Motorsport.

The technicians spent tests in Spain and France, among other locations, working meticulously to find the optimal strategy for energy regeneration on the Nordschleife. The energy regenerated under braking was less than on Pikes Peak, due to the different characteristics of tracks. In the US, the ID.R generated roughly 20 percent of the energy required on board. On the Nordschleife, this figure was about ten percent.

New tracks, new challenges: the aerodynamics of the ID.R have been further developed accordingly.

"Finding the right set-up was a key aspect of our preparations," says Cedric Delnatte, ID.R project lead. "We were able to gain a lot of the knowledge required in this regard during tests at racetracks other than the Nordschleife." Also new were aspects of the brake system on the ID.R, which was converted to carbon-fibre brake disks for the record-braking lap of the Nordschleife. These were not only more robust than the ceramic disks used previously, but they also help to reduce the so-called 'unsprung' mass.

This refers to the mass of all the parts of the car that are not supported by the chassis springs. In the case of the ID.R, these include the wheels and brakes. The unsprung mass affects handling. Rule of thumb: the lower the unsprung mass, the better the driving properties.

Active suspension for improved aero balance

In 2020, the Volkswagen Motorsport engineers made further modifications: the ID.R was kitted out with an active front wheel suspension with variable stand height (Active Ride Height Suspension) for the first time for a test drive at Bilster Berg in September. "We have established from evaluations of our test and record drives that we are reaching the limits with our current chassis", explains Dr. Hervé Dechipre. "In certain situations, we hoped that we could control the front axle in order to optimise the said aerodynamic balance."

Aerodynamic balance is concerned with the relationship between uplift and downforce. This relationship is influenced by the shape of the vehicle and parts, such as spoilers, winglets and flaps, amongst other things. The angle of inclination, namely the angle of the vehicle in relation to the road, can also be optimised. Movement in the vehicle body induced by acceleration and brake force alter this angle. In order to guarantee that the effective forces as well as the vehicle can still be controlled at the optimal level during abrupt manoeuvres, Volkswagen Motorsport has developed an active front axle system. It automatically adjusts the height in order to optimise the balance. There are even advantages when driving at high speeds and with considerable downforce.

"In order to control the height setting, the chassis electrical system has access to numerous pieces of redundant vehicle data", adds Dechipre. "Constantly working with the DRS, drive information, the brakes and the chassis, we opti-

mise the balance in split seconds. Furthermore, the active chassis also offers advantages for the aerodynamic efficiency which has influence on the range of all e-vehicles – the system could even find its use in series production in the future", the engineer responsible for the ID.R's aerodynamics explains.

More work for the driver

Romain Dumas, who was once again at the wheel of the ID.R in 2019 following the previous years' record-breaking drives, was extremely impressed by the job done by the Volkswagen Motorsport engineers. "It is hard to believe that the 2020 ID.R is better and more efficient in every aspect than the car with which I set the record on Pikes Peak in June 2018," says the Frenchman. "Back then, we did not know exactly what awaited us. We had to make compromises in certain areas. In 2020, we were much closer to the limit with the whole car. This is also a bigger challenge for me as a driver.

Test drives on different tracks brought important insights for the development of the ID.R.

Technical data
Volkswagen ID.R

ENGINE	
DESIGN	Fully-electric motor
POWER OUTPUT	500 kW (680 PS)
TORQUE	650 Nm

BATTERY	
BATTERY	Lithium-ion, 8 modules of 56 battery cells each, located in 2 blocks next to the driver and behind the monocoque
CHARGING POWER	Up to 90 kW
CHARGING TIME	20 minutes

POWER TRANSMISSION	
FINAL DRIVE	Permanent four wheel drive with active torque distribution

PERFORMANCE FIGURES	
ACCELERATION	0–100 km/h in < 2 seconds
TOP SPEED	270 km/h

DIMENSIONS AND WEIGHT	
LENGTH	5,200 mm
WIDTH	2,350 mm
HEIGHT	1,200 mm
TRACK WIDTH	1,600 mm
WHEELBASE	2,850 mm
WEIGHT	< 1,100 kg (incl. driver)

CHASSIS	
FRONT/REAR AXLE	Double wishbone suspension
TYRES	Bridgestone Potenza 330-40/18

BODY	
DESIGN	Safety/crash structure at front, carbon monocoque with steel roll cage

Volkswagen is not only developing the electromobility of the future, but also the necessary charging infrastructure.

Study

Focus on sustainable mobility
Volkswagen as pioneer

Volkswagen is assuming responsibility and progressively targeting CO_2 neutrality for vehicles, production and other value creation stages over the coming years.

The Volkswagen Group continues to drive ahead with the system change within individual mobility and is consistently aligning itself with the electric drivetrain. By 2029, Volkswagen will launch roughly 75 new e-models. The number of electric vehicles projected for the coming decade has risen to 26 million.

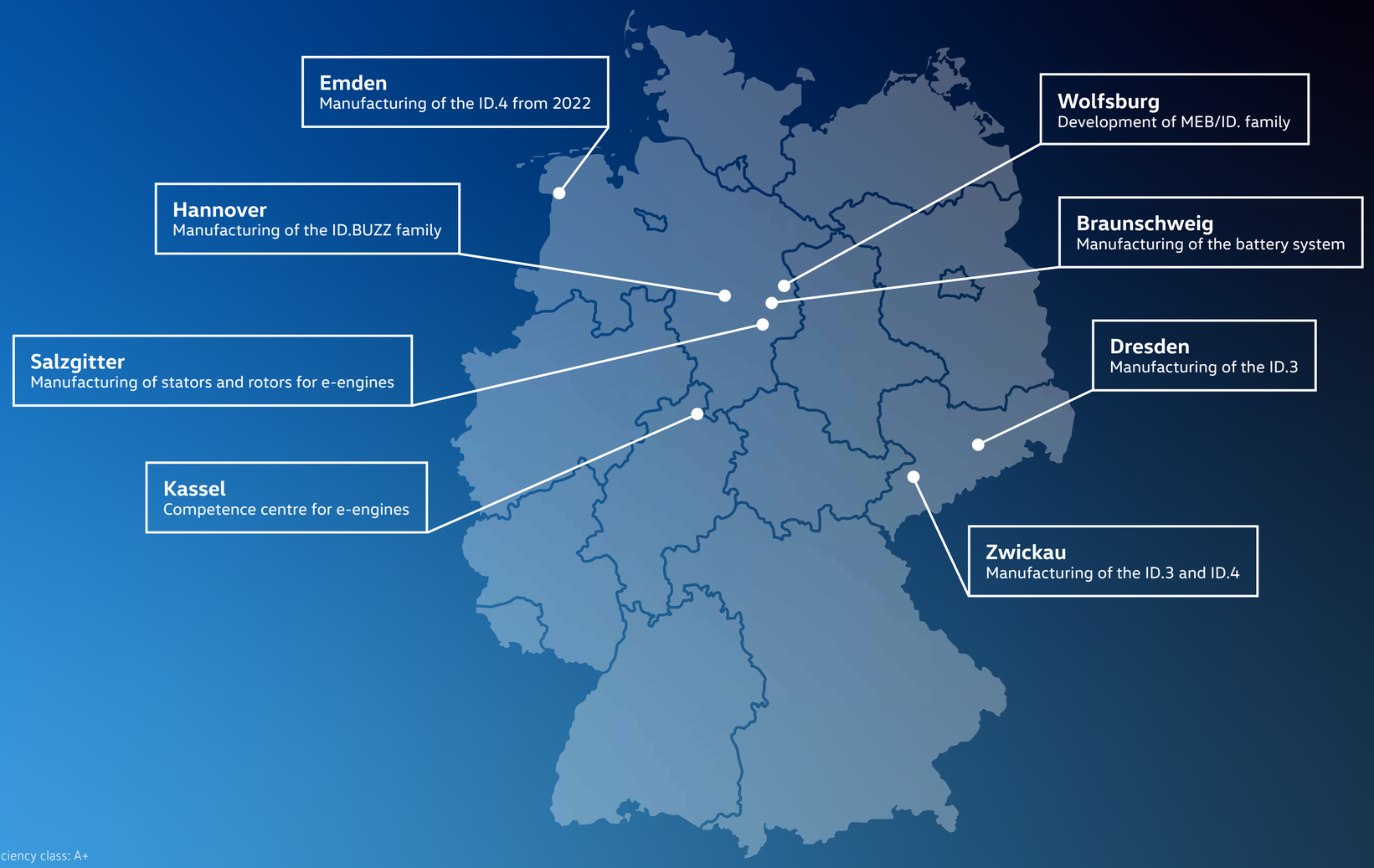
Volkswagen is committed to the goals of the Paris Climate Agreement: to keep the increase in global average temperature to well under two degrees Celsius up to 2050. The Group also aims to be completely CO_2-neutral by 2050. This goes for everything, from the fleet and production to management. By as early as 2025, the CO_2 footprint of the vehicle fleet – across the entire lifecycle – is to be reduced by 30 percent compared to 2015.

Volkswagen locations in Germany involved in MEB production

With this in mind, Volkswagen will invest more than € 33 billion in electromobility across the group by 2024. € 11 billion of this will go into the Volkswagen brand's electric offensive. The transformation towards battery-powered drive-trains is an important tool for Volkswagen, as it strives to achieve climate objectives. For example, the quota of electric cars in the fleet is to rise to at least 40 percent by 2030.

After the ID.R, the sporty forerunner to the ID. range of products, the new ID.3[1] and Volkswagen's first fully-electric SUV – the ID.4[2] – are also being built at the Volkswagen plant in Zwickau. The plant was converted from 100 percent combustion engine to 100 percent electric drive whilst manufacturing operations were still ongoing.

This was the world's first complete and consistent transformation of a major automobile factory to e-mobility. From 2022, fully-electric vehicles will also roll off the production line at the Volkswagen plants in Emden and Hannover. Together with Zwickau and Dresden, these locations will form the largest and most efficient electric vehicle production cluster in Europe.



[1] Power consumption in kWh/100 km: 15.4–14.5 (combined); CO_2 emissions in g/km: 0; efficiency class: A+

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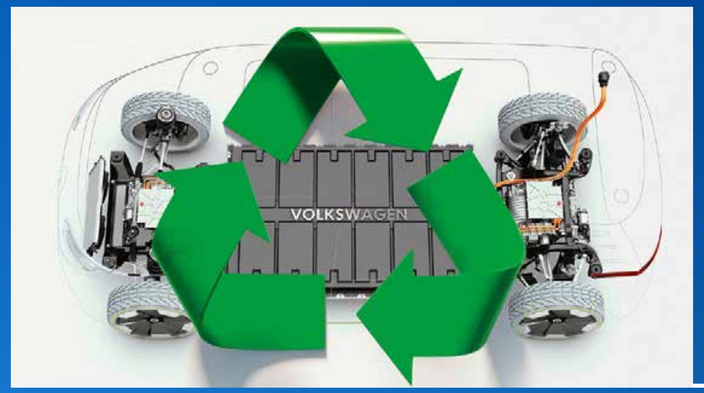


Efficient reuse

The batteries in the ID. range of models consist of many cells. They fill almost the entire area of the car floor, between the two axles. Each battery is efficiently recycled and reused in its so-called "second life" – such as in mobile charging stations.

By opening the MEB up to other manufacturers, and through the related further distribution of the platform, it is possible to significantly reduce the cost of electric vehicles – through the implemented economies of scale, among other things. An initial example of this kind of partnership is the agreed cooperation between Volkswagen and US automobile manufacturer Ford.

In order to secure the electric offensive, Volkswagen has selected strategic battery cell suppliers, in the form of LG Chem, SKI and CATL. In view of the further increase in demand, Volkswagen is planning on manufacturing battery cells with Northvolt in Salzgitter. Production is set to start in 2024 with an initial manufacturing capacity of 16 gigawatt hours. The Volkswagen plant in Braunschweig produces battery systems for e-vehicles based on the MEB.

Milestone in CO_2-neutral mobility

Attractiveness, diversity, sustainability and affordability – along with the main values of emotionality and digitalisation – are the main focus with Volkswagen's electric cars: the ID.3, the first compact car in the fully-electric ID. family, was followed by the ID.4, the brand's first fully-electric SUV. Afterwards production versions of the ID.BUZZ[1], ID.VIZZION[1], ID.SPACE VIZZION[1] and ID.ROOMZZ[1] studies will be launched.

The start of the ID. family was both the launch of the largest electric offensive in the automobile industry and a milestone for climate-neutral mobility. The compact ID.3, which went into production in Zwickau at the end of 2019, is playing a pioneering role: as the Group's first electric car, it is being produced net CO_2 neutrally.

Network of rapid-charging stations in Europe

Before the launch of the ID.3, a host of solutions required by private and commercial e-mobility customers, today and in the future, were gradually implemented – from billing services and additional digital services, through to complete consulting packages. In doing so, Volkswagen is underlining its strategic goal: to become the leading provider of sustainable mobility.

Using the ID.3 can also be CO_2-neutral – if the customer decides to use sustainable electricity. Volkswagen subsidiary Elli not only provides an extensive portfolio of wallboxes and charging solutions, but offers sustainable electricity as well.

"The growth of electromobility on our streets means public charging is becoming increasingly important. With We Charge, Volkswagen is able to offer its customers the right solution to travel quickly and easily in Germany and Europe – electrically, in an environmentally-friendly manner and, above all, comfortably," says Richard van Tatenhove, Head of Digital Charging Services at Volkswagen.

With the joint venture IONITY, Volkswagen is also building a high-performance and sustainable rapid-charging system in Europe.

[1] Study

The initial plan is to install 400 rapid-charging stations on highways throughout Europe. Approximately 100 of these will be located in Germany – roughly one every 120 kilometres. Anyone purchasing a production model from the ID. family benefits from reduced rates for the use of these charging stations.

For safe, fast and easy charging at home, the customer can choose between different varieties of wallbox: the ID. Charger is available in three versions with a charging capacity of 11 kW. Furthermore, Volkswagen is constantly increasing the number of charging points in staff car parks. In the same period, all Volkswagen dealers and service partners in the EU will be equipped with charging facilities, available to customers and the public.

Efficient recycling

The lithium-ion battery is not only an important part of the success strategy for the ID.R race car, but also a key element in Volkswagen's e-offensive. The new and independent brand Volkswagen Group Components is taking end-to-end responsibility for the battery – from developing the skills for manufacturing cells, right through to recycling. At the end of the car's lifetime, the battery can continue to be used in second life concepts – or it becomes a valuable source of raw materials through established recycling procedures.

In any case, come the end of its operating time, the lithium-ion battery is a real treasure trove for the recycling of raw materials, some of which are in short supply. In a new recycling facility in Salzgitter, also innovative recycling procedures for batteries will be researched.

This is what the future looks like: efficient charging at an IONITY fast-charging station.

The ID. family
Looking ahead

The fully-electric models in the ID. range are the embodiment of a technological and social evolution in individual mobility.

Volkswagen entered a new era of the automobile this year, with the first two fully-electric vehicles from the ID. family – the ID.3[1] and the ID.4[2]. They will be followed by a complete family of models, powered solely by electricity. The portfolio ranges from the two production vehicles, the compact ID.3[1] and the ID.4[2] SUV, to the ID.CROZZ[3] SUV Coupé, the multivariable full-size lounge SUV – the ID.ROOMZZ[3], the ID.VIZZION[3] luxury-class saloon, and the ID.SPACE VIZZION[3] estate, as well as the production derivative of the ID.BUZZ[3] – the electric re-incarnation of the iconic Bulli van. The basis for all seven models is the MEB (modular electric drive kit) vehicle architecture, which is designed for purely electric drive. The drive concept of the first derivative of the ID.3 has an electric motor on the rear axle, while the other models each have an optional electric motor on both the front and the rear axle – making them designed for four-wheel drive. As such, propulsion is provided by either just the rear axle on its own or by both axles. Power distribution between the four wheels takes place within milliseconds, through an "electric drive shaft", as soon as this is required for dynamic driving reasons.

This drive control allows the ID. vehicles to adapt quickly to virtually any situation, whether in fast corners on roads or – in the case of the ID.CROZZ or the ID.ROOMZZ, with optional permanent four-wheel drive – on loose surfaces with snow or mud.

The whole drivetrain forms one compact unit. The low centre of gravity of the battery, which is

[1] Power consumption in kWh/100 km: 15.4–14.5 (combined); CO_2 emissions in g/km: 0; efficiency class: A+ [2] Power consumption in kWh/100 km: 16.9–16.2 (combined); CO_2 emissions in g/km: 0; efficiency class: A+ [3] Study

integrated in the floor of the vehicle, gives the ID. models balanced weight distribution and nicely balanced driving dynamics. The capacity of the high-voltage batteries depends on the model. Larger storage capacities will be available as an option.

The batteries in the floor of the vehicles are charged through a cable. Using the rapid-charging system with charging capacities of up to 125 kW, the batteries can be charged to 80 percent in roughly 30 minutes – depending on capacity.

The design of the ID. family
A visionary design that places the person at its heart – and emanates a fascination for electromobility – was developed for the vehicles in the ID. family, all of which are based on the MEB platform. The charismatic front is just as captivating as the flowing and sculptural areas of the outer skin. The large, expressive wheels have been chosen deliberately: they are one of the main design characteristics of electromobility shaped by Volkswagen.

The new styling allows for more available space: the Open Space interiors offer the sense of space and variability of vehicles of the next higher class.

The start of the electric car offensive: the ID.3
As the first production model in the ID. family, the ID.3 launched Volkswagen's offensive on the electric vehicle segment. Like the study, the ID.3 is just over four metres in length. Furthermore, the car features a considerable wheelbase between the front and the rear, which – despite the compact exterior length – is longer than average.

Depending on the battery package, ranges of between 330 and 549 kilometres are possible, according to the new WLTP procedure. Either way, one battery charge should easily make it through a week or more for most people – such as commuters, for example.

Volkswagen's first electric SUV: the ID.4
The ID.4 is a powerful SUV, initially available in four performance levels. The world's top electric

SUV is assembled and sold on three continents – in China, Europe and the USA. The ID.4 has an air of power and confidence on the streets. It features a flowing design, with powerful and sharp lines. They combine a robust SUV character with sophisticated aerodynamics, which allow a c_W value of 0.28 – extremely low for an SUV.

With its trailer coupling, the ID.4 can tow up to 1,200 kilogrammes. A standard roof rail also increases its practicality, making it a practical compact SUV for everyday use – for families, sport and lifestyle. Thanks to its long wheelbase, the interior of the ID.4 is as spacious as an SUV from the next class up. As in all the models in the ID. family, passengers sit in a so-called "Open Space". The large door openings, light interior and large panoramic glass roof, which allows plenty of light into the inside of the car, ensure passengers automatically feel comfortable. The ID.4 also has enough space for three child seats next to each other.

The ID.4 is a master of driving dynamics, as even the architecture of its MEB chassis promises great things: the low centre of gravity makes for an even distribution of axle loads. This ensures that the ID.4 remains smooth and balanced in any situation. A chassis with Dynamic Chassis Control (DCC) is also available as an option. This allows a wide spread between comfort and

All the cars in the ID. family are based on the new MEB platform (modular electric drive kit).

The compact ID.3 heralded a new era of mobility in the summer of 2020.

Power consumption in kWh/100 km: 15.4–14.5 (combined); CO_2 emissions in g/km: 0; efficiency class: A+

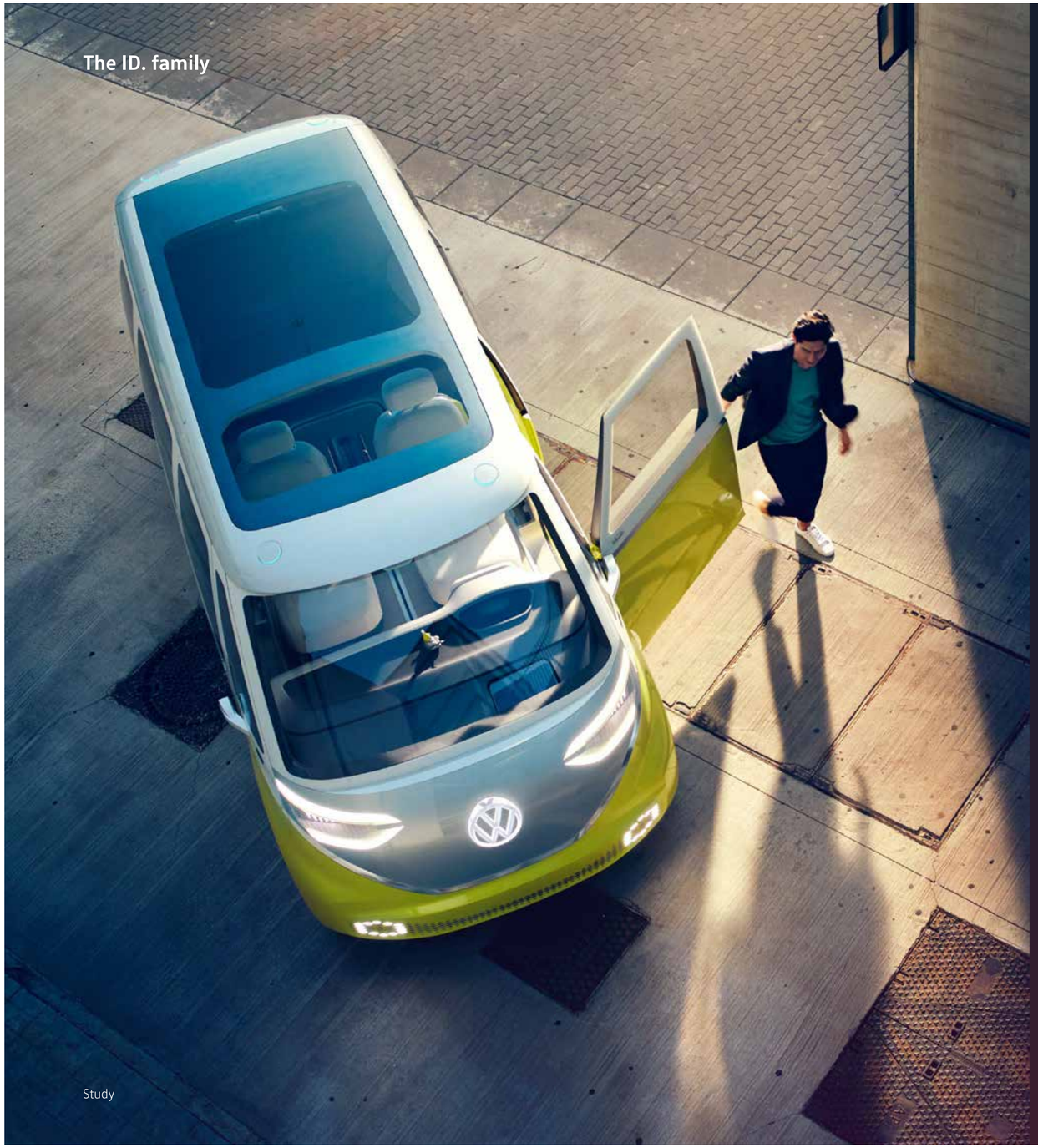
sportiness, controlled via a digital slider on the multimedia system. This technology allows even more subtle variations in the SUV's handling, which is comfortable and yet still very agile.

The crossover: the ID.CROZZ
The production model of the ID.CROZZ is scheduled for launch at the end of 2021. The four-door coupé and sport utility vehicle (SUV) with optional 4MOTION four-wheel drive powertrain is characterised by a wide front end and contoured wings. The ID.CROZZ boasts a variable, lounge-style space concept. The occupants can look forward to four separate integral seats with luxury levels of legroom. It is also possible to completely fold away the rear seats for efficient maximisation of the available space.

The reincarnation of a legend: the ID.BUZZ
The ID.BUZZ, the production variant of which will hit the market in 2022, takes the feeling

The ID.4 is Volkswagen's first electric SUV and can be ordered now.

Power consumption in kWh/100 km: 16.9–16.2 (combined); CO_2 emissions in g/km: 0; efficiency class: A+



Study

The production version of the ID.BUZZ will be launched in 2022.

of freedom that came with the iconic Bulli van and transports it into the next era of mobility. Volkswagen chief designer Klaus Zyciora explains: "With the ID.BUZZ, we did not opt for a retro design on 22-inch wheels, but instead came up with the logical further development of what is certainly the most successful van design in the world."

The zero-emission, all-wheel drivetrain in the ID.BUZZ consists of two electric motors on the front and rear axles (150 kW each). The electric van is a spatial miracle, with up to eight seats and two boots – one at the front, one at the rear. The steering wheel has been completely redesigned. The functionality far outstrips that of a typical multi-functional steering wheel. It does without traditional design elements such as spokes and buttons, replacing these with a type of touchpad that employs capacitive panels.

The ID. range – including the ID.3 – also boasts another new feature: the heads-up display. It uses augmented reality to perform navigation tasks. Information, such as directions from the navigation system, is projected virtually 7 to 15 metres ahead of the front of the car.

The luxury limousines:
ID.VIZZION and ID.SPACE VIZZION

The ID.VIZZION transfers the design DNA of the ID. models to the world of grand limousines. The controls transport you to 2030, while automated driving to level 4 could well be available on certain routes in 2025.

Speech and gesture controls allow the ID.VIZZION to drive completely autonomously. The Smart Device becomes the chauffeur, as there are some situations in which it does not require the driver's attention. This allows the ID.VIZZION to provide its passengers with the freedom they need on the road – to relax, to communicate, or to work.

The electric all-wheel drivetrain shows that the future is very much now, as its two motors produce a system performance of 225 kW with a range of up to 600 kilometres. With the ID.SPACE VIZZION, Volkswagen is also taking its e-mobility offensive into the world of the estate.

The luxury SUV: ID.ROOMZZ

The ID.ROOMZZ is the multi-variable all-round model in the ID. family, based on the MEB. It is the seventh concept car and provides a first look at the upcoming production version of the lounge-style, zero-emission SUV.

The ID.SPACE VIZZION (left) is e-mobility in the world of the estate. The ID.ROOMZZ (below) is the luxury SUV of a new generation.

In addition to an exterior design that sparkles with seamless transitions, the special feature of this car is a new interior architecture that concentrates on individuality and variability. It has a range of seating configurations that can be adjusted to each driving mode. Top quality materials are used throughout, combined with the option to personalise the lighting elements. To allow the driver to get full enjoyment of this interior as well, the production version will also have the full range of IQ.DRIVE systems on board. Intelligent driver assistance will turn any drive into a relaxing journey for all passengers. The fully-electric luxury SUV will be on the market in China in 2021. Further markets will follow.

Form and colour
The ID. family design

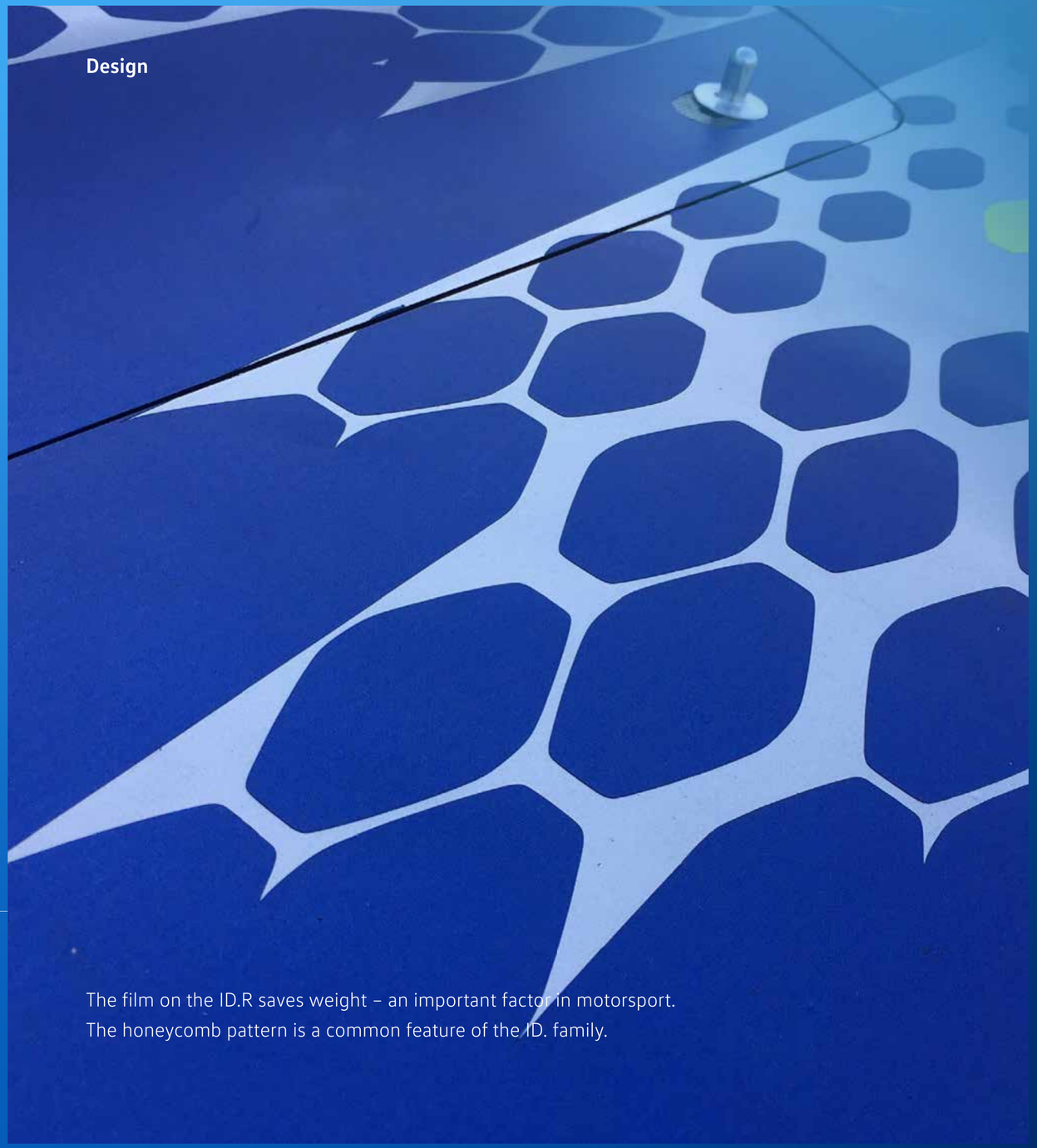
The similarities between the ID.R and the production models in the ID. family go way beyond the electric drivetrain. The parallels in form and colour are also a result of the close cooperation between the Motorsport and the Design department.

Since the start of the project in 2017, the ID.R has changed its appearance on several occasions. First grey, then blue, then red, and last, but not least: blue and silver. The design team at Volkswagen deliberately chose the new colours, in order to further illustrate the link between motorsport and production, as the blue is a distinguishing feature of Volkswagen Motorsport and Volkswagen R. Scale Silver has been taken from the colour programme for the ID.3[1], the first production model in Volkswagen's series of fully-electric vehicles, which has been available to order since 20 July 2020.

Honeycomb plays an important role
As well as the colour, the honeycomb pattern is also a defining element. On the ID.3, this can be found on the front skirt and C-pillars, for example. In the case of the 500 kW (680 PS) ID.R, the exterior is not the only place that honeycomb plays a role. Inspired by the form of the honeycomb, the tremendously rigid hexagons find application in composite materials in the monocoque and in the aerodynamic components of the electric race car.

Another characteristic of the entire ID. family is the black roof. "On the ID.R too, the film application stops at the shoulder line on the monocoque and only continues upwards with an aluminium frame on the windscreen, which is only drawn into the side air intake like a C-pillar," says Marco Pavone, Head of Exterior Design Volkswagen. "That comes from the ID. family, primarily from the ID.3. This chrome accent can also be found on the A-pillar, roof frame rail and C-pillar on the ID.3. This is a feature common to all ID. models."

[1] Power consumption in kWh/100 km: 15.4–14.5 (combined); CO_2 emissions in g/km: 0; efficiency class: A+



The film on the ID.R saves weight – an important factor in motorsport.
The honeycomb pattern is a common feature of the ID. family.

Visible member of the ID. family
The closeness to the ID. family was an important premise for the design team. "If we are going to do it, the ID.R must immediately be recognisable as a member of the ID. family," says Pavone about the specifications. "That is obviously extremely challenging, as you have to pay attention to other things when you are designing a high-performance vehicle."

Despite the aerodynamic challenges, this requirement has been met, and Pavone believes "that customers and motorsport fans recognise the car as a member of the ID. family – even if you were to completely remove the decals."

Film beats paintwork
During the development process, the design team faced some special challenges, such as the limited options for implementing the design on film. "The wheel arches on the ID.R stretch a long way up. The film must therefore be able to deal with a large deformation," says Pavone.

During the application process, the film is warmed, in order to pull it over the shape of the car. However, the film can only be stretched so far. "If you overdo it, it could tear," explains Pavone, adding: "If you were to print a design like the ID. honeycomb on the film and then deform this in a three-dimensional manner, the honeycomb structure would no longer look right."

For this reason, consideration was given on several occasions to the possibility of painting parts of the ID.R. "Ultimately, we always came back to the film, as this is lighter on the bodywork than painting. Weight is a critical issue in motorsport," says Pavone. Nonetheless, the cooperation with Volkswagen Motorsport on what is now the fourth design for the ID.R succeeded in clearly positioning the electric race car as a member of the ID. family. "I see something modern. I see that it is an ID. car, and that it is electric," says the designer.

ID.3: power consumption in kWh/100 km: 15.4–14.5 (combined);
CO_2 emissions in g/km: 0; efficiency class: A+

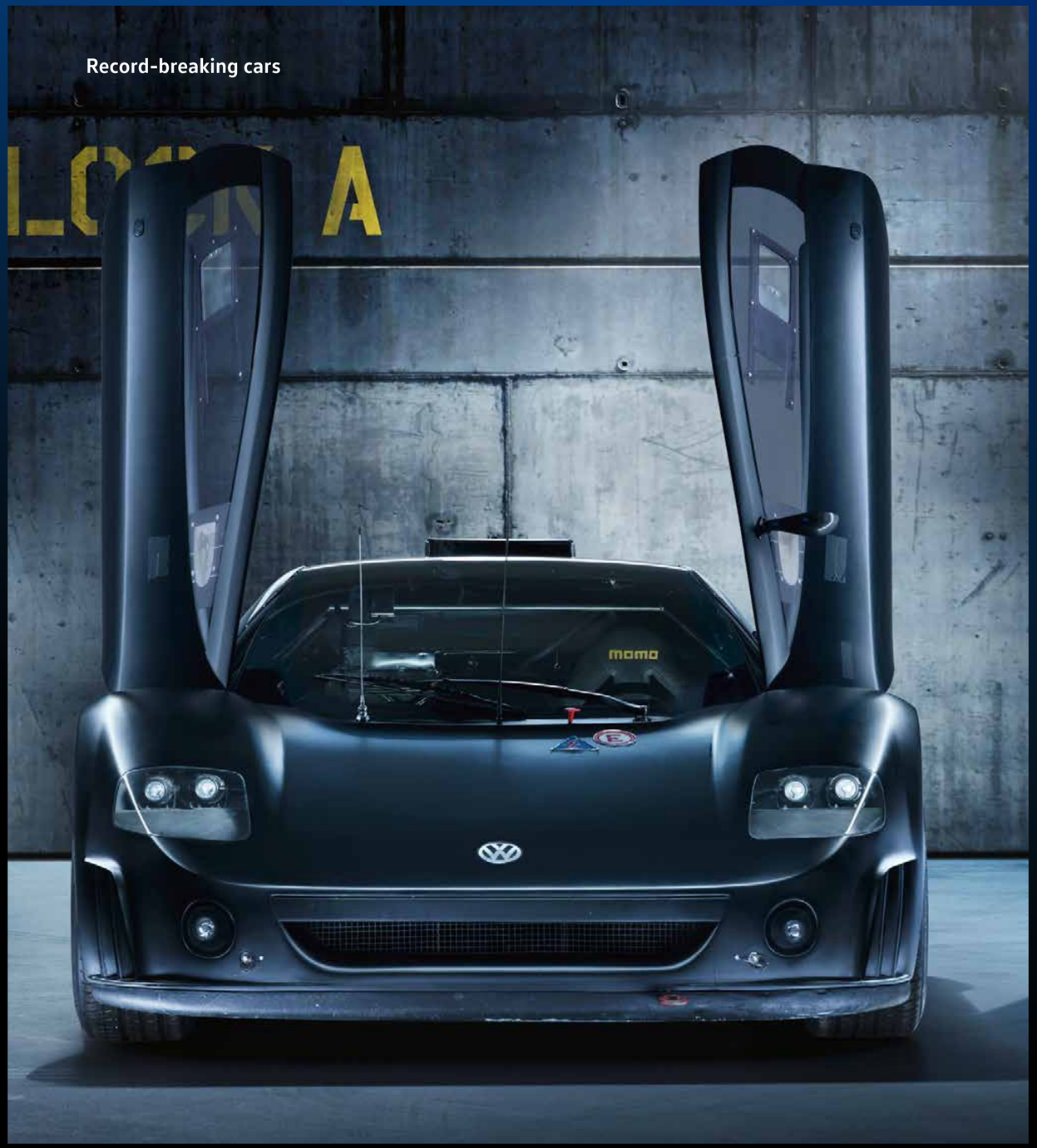
Record-breaking cars
Records for eternity

Volkswagen vehicles have set many records. Some of them still stand to this day. Take a look in the history books.

As well as success in motor racing, world records are a good way of showcasing the potential of new technology. The most important "World Land Speed Records" are officially approved by the International Automobile Federation, the FIA. They exist for distances from a quarter of a mile (about 402 metres) to 100,000 miles (about 161,000 kilometres), or for a period of time – up to 24 hours nowadays, up to a remarkable 168 hours in the past.

Although the importance of extreme endurance records has decreased nowadays, in light of regular tests amounting to

Modest engine power, huge top speed: the aerodynamically-sophisticated ARVW test vehicle.



Record-breaker par excellence: the W12 Nardo quite rightly bears the name of the high-speed circuit in the Apulia region.

several million kilometres, manufacturers still like to go in pursuit of records. Whether with production cars or modified vehicles, they are forever pushing the boundaries of what is possible. Volkswagen has regularly set benchmarks in this field. Here's how.

ARVW, the diesel ambassador

The success story of the diesel engine in the passenger car sector began in the 1980s. Volkswagen wanted to use its ARVW test vehicle (Aerodynamic Research Volkswagen) to show what this new technology "made in Wolfsburg" was capable of. One of the best locations to do so was the high-speed track in the Southern Italian town of Nardò. In October 1980, the five-metre long ARVW, with its aerodynamically-sophisticated plastic bodywork (c_w value: 0.15), embarked on a momentous record attempt.

Despite its unimpressive power output of 129 kW (175 PS), the concept car achieved a massive top speed of 362 km/h. Even more remarkable was the fact that the ARVW set an average speed of 355.88 km/h in the first hour. The three-man team of drivers set two

world and six class records, two of which still stand today[1].

G-Lader survives litmus test
Volkswagen introduced a special forced-induction technology – the so-called G-Lader – in the Polo in the mid-1980s. The name refers to the inner structure of the G-Lader, which resembles the letter "G". Technically speaking, the G-Lader was a scroll compressor. While the turbocharger is rotated by the flow of exhaust gas, the G-Lader is driven by a belt.

To promote this technology, which was new to the passenger car sector at the time, three modified Polo G40 cars with 1.3-litre engines embarked on an endurance run at the Volkswagen Group test facility in Ehra-Lessien, near Wolfsburg, in August 1985. With their power ramped up to 94 kW (129 PS), they set their sights on the 24-hour record – and broke it: the G-Lader turbocharger passed the litmus test. Over the course of the 24-hour record attempt, the team set a new average speed record for its class of car – 208 km/h – and also cracked the 5,000-kilometre mark for the first time.

W12 Nardo provides the basis for the Phaeton
Shortly after the turn of the millennium, Volkswagen launched the Phaeton, a luxury-class saloon, the top-of-the-range model of which was eventually available with a twelve-cylinder petrol engine. To once again underline the brand's technological expertise, the CEO of Volkswagen AG sent another team to Nardò in pursuit of more records in October 2001. The performance of the new engine was increased to 441 kW (600 PS) – a spectacular achievement at that time. The concept car, the heart of which beat with twelve chambers, was named the W12 Nardo. Six drivers alternated at the wheel of the super sports car. By the end of the 24 hours, they had set ten world and class records.

The average speed over 24 hours was just under 300 km/h. However, those involved were plagued by the fact that they had just missed the magical 300 mark. A second attempt was authorised. In February 2002, the team actually far surpassed their own achievements and added another two records, taking their total number of world records to six. The most prestigious of those was the average speed of 322.891 km/h over a duration of 24 hours. Remarkably, the W12's records still stand today.

In 1985, Volkswagen set a new 24-hour speed record with a modified Polo G40.

[1] As of 03/2021

A success story
From racetrack to production

At Volkswagen, the letter R is intrinsically linked with success in motorsport. The Group's new premium performance brand is now also focussing on electric vehicles.

Volkswagen R – a success story, the likes of which you might find in a book: four-time world rally champions with the Polo R WRC and two titles with the Polo R Supercar in the World Rallycross Championship. From 2018, a new approach was taken with the ID.R. For the first time, the division responsible for Volkswagen's top performance cars was involved in a project centred around a fully-electric drivetrain. And success was not long in coming, in the form of a new all-time record on Pikes Peak, fastest times on Tianmen Mountain, in Goodwood and at Bilster Berg, and the e-record on the Nürburgring-Nordschleife. The knowledge acquired in achieving this success has been incorporated in the development of an entire series of electric production vehicles: the ID. family.

The R family is growing rapidly

At the same time, the R family is also growing rapidly, thanks to new production models: in the T-Roc R[1] CUV and the Tiguan R[2] SUV, two expressive performance cars are available. The Arteon R[3] and the Arteon Shooting Brake R[4] are two attractive, upper mid-range vehicles that complement the range with luxurious and sporty vehicles. Furthermore, in November 2020, the Golf R[5] was introduced, based on the eighth generation of the Golf. With an electronically controlled four-wheel drive system, featuring R-Performance Torque Vectoring, the Golf R, like the Tiguan R and the Arteon R, is equipped for every situation. Volkswagen R's full-size SUV, the Touareg R[6], is the brand's first electrified model and rounds off the portfolio in the premium sector. During the development of the new plug-in hybrid drivetrain, the focus was on achieving uncompromising performance with low emissions.

Volkswagen R vehicles, and the R-Line equipment line, are renowned for the performance, know-how and attention to detail, which have been transferred from motorsport to road vehicles. Technology developed under the extreme conditions encountered at the racetrack gives buyers the peace of mind that their vehicle will reliably do its job, whilst at the same time being a pleasure to drive – today and in the future.

[1] Fuel consumption in l/100 km: urban 9.3, extra-urban 6.9, combined 7.8; combined CO_2 emissions, g/km: 179; efficiency class: E

[2] Fuel consumption in l/100 km: urban 10.2, extra-urban 7.0, combined 8.1; combined CO_2 emissions in g/km: 186; efficiency class: D

[3] Fuel consumption in l/100 km: urban 10.1–9.9, extra-urban 6.6–6.4, combined 7.9–7.7; CO_2 emissions (combined) g/km: 180–176; efficiency class: D–C

[4] Fuel consumption l/100 km: urban 10.1–9.9, extra urban 6.6–6.5, combined 7.9–7.7; CO_2 emissions in g/km (combined): 181–177; efficiency class: D–C

[5] Fuel consumption in l/100 km: urban 9.0, extra-urban 5.9, combined 7.0; CO_2 emissions in g/km (combined): 161; efficiency class: D

[6] Fuel consumption in l/100 km: combined: 3.0–2.8; power consumption, kWh/100 km: combined 19.9–19.5; CO_2 emissions, g/km: combined: 69–63; efficiency class: A+

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