

FACT SHEET XXL

WEC 2017

SCHAEFFLER

Schaeffler and the Porsche LMP Team

World Champions!

Schaeffler and Porsche win the WEC for the third time running and achieve a Le Mans hat-trick



Editorial



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Automotive

2014 marked the beginning of the partnership between Schaeffler and Porsche in the WEC. Four years later, the tally is extremely impressive. After 2015 and 2016, we again crowned ourselves drivers' and manufacturers' champions this season. And in the legendary 24-hour

race at Le Mans, we achieved a hat-trick as well. The 34 races in total, with gripping competition and electrifying technology, made the hearts of the fans and the engineers involved beat faster. Thanks to a set of regulations that emphasizes the efficiency of the vehicles, there's an active exchange between motorsport and production in the WEC, technology transfer being the keyword: an ideal platform for Schaeffler. We take part in developing "Mobility for tomorrow" with our ideas and products.

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Technology prototype The Porsche 919 Hybrid won the WEC from 2015 to 2017

Efficiency and

high tech

The FIA World Endurance Championship (WEC) represents the ultimate of all world championships. The high-tech LMP1 race cars are fully focused on efficiency

Races in Europe, America and Asia, race durations of six to 24 hours and the participation of renowned manufacturers such as Alpine, Aston Martin, BMW, Ferrari, Ford, Toyota and Schaeffler's partner Porsche – the FIA World Endurance Championship (WEC) has been thrilling motorsport fans around the globe since 2012.

The absolute highlight on the calendar: the legendary 24-hour race at Le Mans. Schaeffler as manufacturer Porsche's partner is in the thick of the action. In 2015, 2016 and 2017, the two companies jointly won the drivers' and

manufacturers' world championships, plus the iconic race at Le Mans, respectively.

Characteristic for the WEC are its revolutionary regulations. Since 2014, in the top category, LMP1, in which Porsche competed with two 919 Hybrid cars, the output of the race cars has no longer been controlled by the regulations. Instead, their energy consumption (in megajoules) has been subject to control – in other words, not the amount that arrives at the wheels but that which flows into the fuel tank and batteries and is ultimately used. This rewards the most efficient contenders and no longer the most powerful ones.

Technology transfer

As a result, a perfect parallel has been created, as the engineering designers for volume production keep inventing increasingly efficient

automobiles, relying – just like in the WEC – on continually improving hybrid systems. Progress doesn't stop.

In 2017, the Porsche 919 Hybrid is again competing in the highest energy efficiency class established by the regulations. This means that on a 13.629-kilometer lap at Le Mans, the car is allowed to use eight megajoules of recuperated energy while being limited to a maximum fuel consumption of 4.31 liters. Both consumption levels are closely monitored and accounted for after each lap. For the recuperation technology used in the 919 Hybrid, Porsche relied on a combination of kinetic energy recuperation at the front axle and conversion of exhaust energy into electricity. The electrical energy is placed into interim storage in lithium-ion batteries and can be accessed to boost output by the driver pushing a button. ■

2014 season



Comeback Porsche competes in the WEC top category again for the first time since 1998

A promising year of learning

It celebrates its debut in 2012: the FIA World Endurance Championship (WEC) which includes the legendary 24-hour race at Le Mans. From the very beginning, the organizers opt for hybrid technology in the top LMP1 category. In 2014, a revolutionary set of regulations comes into effect for this class with the main focus placed on efficiency: ideal prerequisites for Porsche. The Stuttgart-based brand returns to the top class of endurance racing with the 919 Hybrid following a 16-year absence and meets with Audi and Toyota: ideal prerequisites for Schaeffler as well. The company based in Herzogenaurach performs pioneering work in the development of hybrid systems for production cars. The inaugural season is a promising one. On making its racing debut at Silverstone, the 919 clinches its first podium finish and just a race later, the sports prototype celebrates its pole premiere. In the season finale at São Paulo, Romain Dumas, Neel Jani and Marc Lieb score the first WEC victory for Schaeffler and Porsche.



Final drivers' standings

P	Drivers		Pts
1	Davidson/Buemi	Toyota	166
2	Lotterer/Tréluyer/Fässler	Audi	127
3	Lieb/Jani/Dumas	Porsche	117
4	Di Grassi/Kristensen	Audi	117
5	Wurz/Sarrazin	Toyota	116
6	Lapierre	Toyota	96
7	Duval	Audi	81
8	Nakajima	Toyota	71
9	Hartley/Webber/Bernhard	Porsche	64.5
10	Beche/Heidfeld/Prost	Rebellion-Toyota	64.5

Final manufacturers' standings

P	Manufacturer	Pts
1	Toyota	289
2	Audi	244
3	Porsche	193

- 1 Strong showing** Porsche at the Le Mans premiere of the two 919 Hybrid cars leads the race for a long time in front of top dogs Audi
- 2 Big name** Grand Prix winner Mark Webber continues his career with Schaeffler and Porsche in the WEC
- 3 Debut victory** Neel Jani, Romain Dumas and Marc Lieb win the season finale at São Paulo

2015 season

On course for success



1

Schaeffler and Porsche are the measure of all things as early as in their second season. The updated 919 Hybrid dominates the season with six victories in succession plus an early win of the manufacturers' title and position one in the drivers' standings achieved by Timo Bernhard, Brendon Hartley and ex-Formula 1 star Mark Webber. In the season's thrilling pinnacle event at Le Mans, the third 919 Hybrid of

Nico Hülkenberg, Earl Bamber and Nick Tandy which Porsche has additionally fielded comes out winning, which marks the first overall victory for the Stuttgart-based brand at La Sarthe since 1998. Immediately following Le Mans, the WEC goes on to race at the Nürburgring, the first WEC event in Germany. In the inaugural race on home soil, Schaeffler and Porsche celebrate a one-two win. ■



2



3

- 1 **First time** Timo Bernhard, Brendon Hartley and Mark Webber with four victories in succession clinch the drivers' title
- 2 **Strong conclusion** At the season's finale in Bahrain, Marc Lieb, Neel Jani and Romain Dumas in car number 18 are victorious
- 3 **Upbeat mood** The Porsche drivers jubilate on clinching the WEC titles and sixth victory of the season in Bahrain
- 4 **Reinforcement** At Le Mans, Porsche fields three cars. Nico Hülkenberg, Earl Bamber and Nick Tandy win in the white number 19

Final drivers' standings

P	Drivers	Pts
1	Hartley/Webber/Bernhard	166
2	Lotterer/Tréluyer/Fässler	161
3	Lieb/Jani/Dumas	138.5
4	Duval/Di Grassi/Jarvis	99
5	Davidson/Buemi	79
6	Wurz/Conway/Sarrazin	79
7	Nakajima	75
8	Tandy	70.5
9	Bamber/Hülkenberg	58
10	Canal/Rusinov/Bird	33.5

Final manufacturers' standings

P	Manufacturer	Pts
1	Porsche	344
2	Audi	264
3	Toyota	164
4	Nissan	0



4

2016 season

Successful title defense



Final drivers' standings

P	Drivers	Pts
1	Lieb/Jani/Dumas Porsche	160
2	Duval/Di Grassi/Jarvis Audi	147.5
3	Kobayashi/Conway/Sarrazin Toyota	145
4	Hartley/Webber/Bernhard Porsche	134.5
5	Lotterer/Fässler Audi	104
6	Tréluyer Audi	70
7	Imperatori/Kraihamer/Tuscher Rebellion-AER	66.5
8	Davidson/Nakajima/Buemi Toyota	60
9	Menezes/Lapierre/Richelmi Alpine-Nissan	47
10	Rusinov Oreca-Nissan	36

Final manufacturers' standings

P	Team	Pts
1	Porsche	324
2	Audi	266
3	Toyota	229

Successful The two Porsche 919 Hybrid cars win six of nine races in 2016

The boom of the WEC, which extends its calendar to nine events and races in Mexico for the first time in 2016, continues. Porsche keeps developing the 919 hybrid sports car to new levels over the winter and this will pay off. With six victories claimed during the season following a close battle with Audi, Schaeffler's partner defends the manufacturers' title. In the season's dramatic pinnacle event at Le Mans, in which the Toyota that had been leading the race for a long time, coasts on the last lap, Neel Jani, Marc Lieb and Romain Dumas clinch overall victory for Schaeffler and Porsche which lays the foundation for their subsequent win of the drivers' classification. ■



1



2



3

1 Impressive setting In Japan, the WEC races at the foot of famous Mount Fuji

2 Farewell Mark Webber retires from his active career following the season finale in Bahrain and is showered with champagne by his teammates

3 Finally 18! The subsequent world champions, Romain Dumas, Marc Lieb and Neel Jani, claim Porsche's 18th Le Mans victory

High-tech wonder

The hybrid powertrain in the Porsche 919 combines downsizing turbo technology with efficient gasoline direct injection in a two-liter V4 IC engine. A lithium-ion battery serves as an accumulator for the electrical energy from two different recuperation systems – braking energy from the front axle and exhaust energy

Hybrid systems

KERS with a motor-generator-unit (MGU) on the front axle, ERS for recuperation of exhaust energy

Dimensions

Length 4,650 mm
Width 1,900 mm
Height 1,050 mm
Weight 875 kg

Output

IC engine < 500 HP on the rear axle
MGU > 400 HP on the front axle

Brakes

Hydraulic dual-circuit braking system, mono block light metal brake calipers, ventilated carbon fiber brake discs front and rear, brake force distribution infinitely variable by the driver, the front brakes recuperate energy

IC engine

V four-cylinder engine (90-degree bank angle) with turbocharger, four valves per cylinder, 2,000 cc cubic capacity, DOHC, one Garrett turbocharger, gasoline direct injection

Suspension

Independent front and rear, pushrod system with adjustable dampers

Wheels/tires

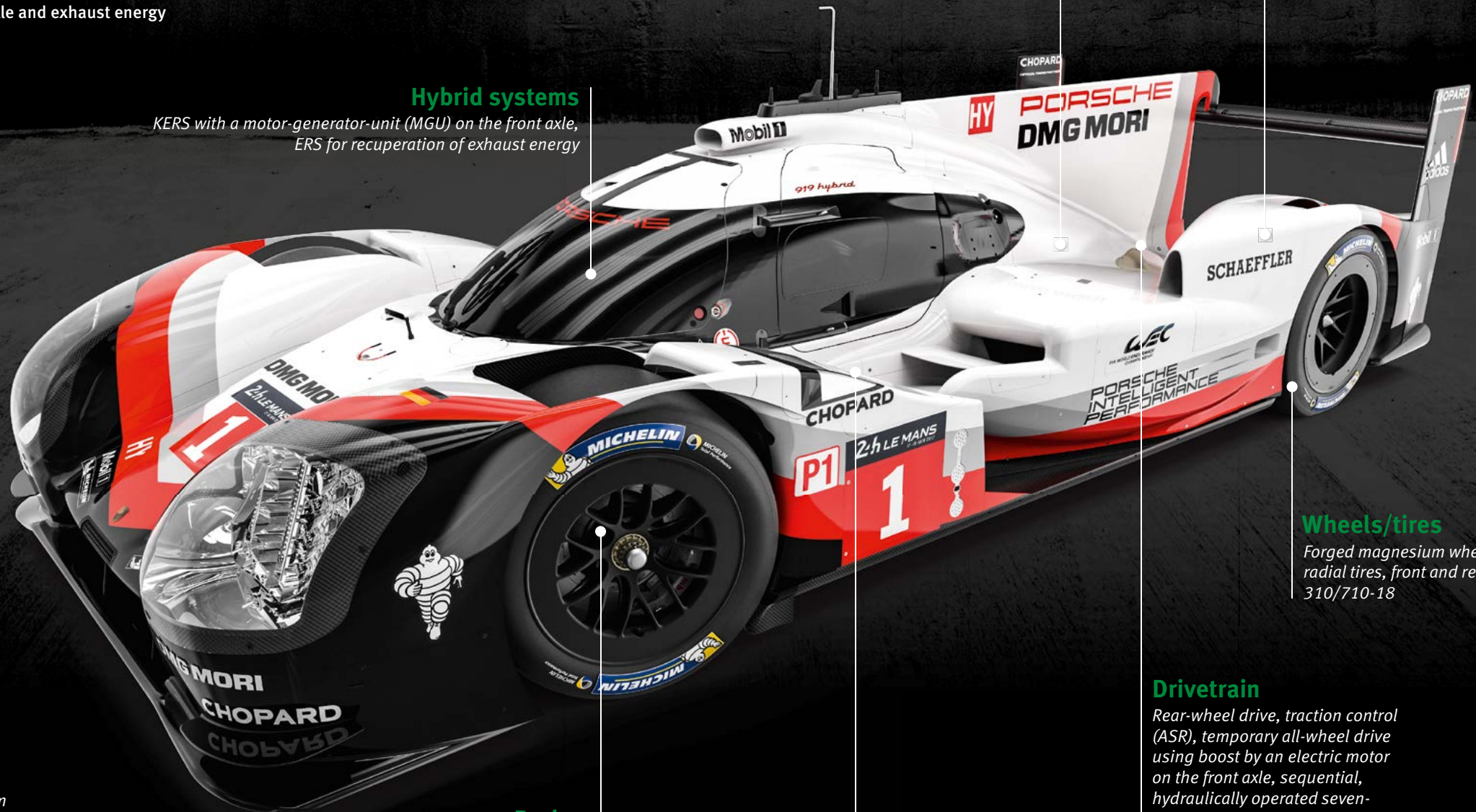
Forged magnesium wheels, radial tires, front and rear: 310/710-18

Drivetrain

Rear-wheel drive, traction control (ASR), temporary all-wheel drive using boost by an electric motor on the front axle, sequential, hydraulically operated seven-speed racing transmission

Monocoque

Fiber-reinforced construction of carbon fibers with aluminum honeycomb core



Technology *elite*

The FIA World Endurance Championship (WEC) with Le Mans as the pinnacle event of the season is regarded as one of the most challenging motorsport series in terms of technology. Thanks to a healthy mix of innovation and reliability of the vehicles, Schaeffler's partner Porsche celebrated major successes since 2014

High speed and high tech – the WEC combines both to a special degree, efficiency being the magic word. Which team, which manufacturer makes the best use of the opportunities provided by the regulations and technology? At the moment, there's hardly another more attractive, let alone more creative, stage to demonstrate the innovative prowess of high-end hybrid sports cars. The season's pinnacle event, the 24 Hours of Le Mans, in which the drivers

are on track four times as long as in the season's other races, makes anything else pale in comparison. Thanks to a complex set of regulations for the top category, LMP1, which has been in effect since 2014, the fastest contender at Le Mans is necessarily always the most efficient one as well. The one having covered the longest distance within 24 hours has extracted the maximum from a limited amount of fuel. Due to the major technological freedom in the areas of hybrid and powertrain technology, the manufacturers surprise with ever-new innovation impulses while delivering thrilling on-tarmac action in the process. This year, Schaeffler's partner Porsche won the WEC and Le Mans for the third time in succession.

Ideal platform for Schaeffler

Efficiency, high tech and reliability. In the WEC and at Le Mans, exactly the same topics

matter which now are in absolute focus in automotive engineering, and thus at Schaeffler, and will continue to be in the coming decades. The analogy between motorsport and production very closely approaches its original meaning again. The things that prove viable and win out in the world's toughest races demonstrate their fitness for use in production as well. The innovation-friendly regulations suit manufacturers and automotive suppliers like Schaeffler who aim to prove their technology expertise and the

The world's toughest test laboratory

The fascination exuded by Le Mans. The iconic French endurance race demands maximum performance twice around the clock – of humans and hardware, as well as of the engineers in the development laboratories. Revolutionary technologies have frequently passed their baptism of fire at Le Mans and subsequently went on to become firmly established in volume production. A short summary of past achievements: streamlined body styles, lightweight design, disc brakes and hybrid drive.

“The 24 Hours of Le Mans pushes both man and machine to their absolute limits”

Fritz Enzinger
Head of LMP1 at Schaeffler's partner Porsche

Schaeffler and Porsche @ Le Mans 2017



The video on the spirit of Le Mans. You can only win the toughest race in the world with teamwork

suitability of their visionary designs in front of large audiences around the globe.

24 Hours of Le Mans facts

815.6 kWh

was recuperated by the victorious Porsche 919 Hybrid in 2017. This energy would allow an electric car¹ to cover a distance of 6,473 kilometers

250 km/h

Average speed per lap, 220 km/h over the entire race duration

50 to 60 l

of racing fuel per 100 kilometers were consumed by a Porsche 956 in the 1980s – nearly twice the amount of the current, much faster 919 Hybrid whose “thirst” is limited to about 32 liters

19 victories

No brand has mounted the very top of the podium more often than Porsche

For manufacturers and suppliers, Le Mans is a paradise. For Schaeffler, the legendary 917, for example, was a development prototype for valve train components that were subsequently produced by the millions. The development of turbochargers profited from Le Mans as well. In 1976, Porsche achieved the first victory of a turbocharged engine there.

Teamwork, momentum, determination

Success in motorsport is closely tied to the abilities of every individual but, above all, to teamwork. Motorsport demands innovation prowess and momentum, determination and courage – the same applies to Schaeffler’s employees in their daily pursuit of standing the company’s ground and furthering its position as a globally leading automotive supplier.

High-end technology paired with emotions – the motorsport commitment has been a vital element of Schaeffler’s brand strategy for decades, be it with high-tech hybrids in the WEC, touring car action in the DTM or in the electrifying Formula E.

“The perfect stage”



Why do you have a joint commitment with Porsche in the WEC?

The answer is simple. Hybrid is becoming an increasingly important automotive topic – both on the road and in motorsport. In the WEC regulations, energy efficiency and forward-thinking technology play the key role.

What are you aiming to prove? Technological expertise. And the WEC, including Le Mans, provides the perfect stage for

it. Especially in endurance racing with its extremely high demand for reliability we consistently learn new things.

But this is true as well for Formula E in which you’ve been on board ever since the inaugural season ...

Exactly. This is where we explore extremes. After all, at Schaeffler, we have and continue to gather a lot of know-how relating to the combination and interaction of units and

Prof. Peter Gutzmer Deputy CEO and Chief Technology Officer of Schaeffler AG

components. In Formula E, it is between the electric motor and the transmission, or in the WEC’s hybrid, it’s between the IC engine and the electric motor. In addition, motorsport is emotion – and that’s what we need in electric mobility as well. That’s why both series are ideal fields of activity for our company.

EFFICIENT MOTORING

Small engines save weight and with modern technology modern engines are genuine power plants despite having less cylinders – both on the race track and on public roads. Combined with systems to recuperate energy such as for example the recovery of brake energy (i.e. recuperation) the consumption level sinks significantly.

E-Boost through energy recuperation
The Porsche 919 Hybrid is equipped with two systems for energy recuperation. On one hand, braking energy is recovered on the front axle by recuperation, and on the other exhaust energy is used via an E-generator driven by the exhaust gas flow. This recovered energy is stored in the battery and used for boosting lap by lap.

Variable valve control
Enables variable control of the valves through camshaft regulation synchronised to the actual driving situation.

Turbocharger
In addition to vibration damping, the turbocharger is an important downsizing component. Ideally, friction-optimised by low-friction roller bearings.

Lower consumption

91*	4.91*
-45%	

■ VW Golf 1, 1974
■ VW Golf 7, 2017
*Consumption in l/100 km

Hybrid module
Schaeffler offers different hybrid modules for the bespoke electrification of the drivetrain – from compact class to SUV.

History of downsizing

1970 Porsche 917	1994 Porsche 962	2017 Porsche 919 Hybrid
12 cylinders, 4.5 l displacement, 383 kW	6 cylinders, 2.9 l displacement, 500 kW	4 cylinders, 2.0 l displacement, ϵ 368 kW + E-motor, > 294 kW

EXTREMELY RELIABLE

Extreme loads necessitate absolutely reliable components. This applies not just to motorsport, but also for everyday road traffic or energy generation by wind power. Schaeffler does not only offer comprehensive expertise in the field of bearing technology, but always has an integrated view for the entire system. Because the result is often more than only the pure sum of its parts.

1. Centrifugal pendulum absorber
Modern centrifugal pendulums absorb oscillations. They sit between engine and gearbox and are the key to low revs and therefore low consumption.

4. WPOS spherical roller bearings
The durable bearing for all wind turbines guarantees the greatest reliability. Ingenious know-how ensures low friction and lowest wear.

2. Twin tandem wheel bearing module with spur gear teeth
Low-friction ball bearings combine low resistance with increased cornering rigidity. The spur gears combine increased strength with maintenance optimised mounting.

3. Ball bearing mounted balance shaft
Small engines need modern assistance such as balance shafts. With their low friction and lightweight, they have a positive influence on consumption, emissions and service life.

An entire racing season in only 24 hours

1x Le Mans \approx 17x F1 race

The race distance of the 24 Hours of Le Mans corresponds to almost an entire Formula 1 season. Man and machine are loaded to breaking point for some 5,300 km. Even the most insignificant component can decide between victory or defeat.

¹BMW i3 (94 Ah/battery 27.2 kWh; 12.6 kWh/100 km)

Teamwork is crucial

In the WEC endurance races run for six hours – or even 24 as in the case of Le Mans – three drivers typically form a team, taking turns at the wheel after about two hours of racing. For the two 919 Hybrid cars in the field, Porsche could rely on an experienced sextet

Porsche 919 Hybrid #1

Porsche 919 Hybrid #2

Porsche 919 Hybrid #1		Porsche 919 Hybrid #2	
Neel Jani	André Lotterer	Nick Tandy	Earl Bamber
Vita	Vita	Vita	Vita
Date of birth December 8, 1983	Date of birth November 19, 1981	Date of birth November 5, 1984	Date of birth July 9, 1990
Place of birth Rorschach (CH)	Place of birth Duisburg (D)	Place of birth Bedford (GB)	Place of birth Wanganui (NZ)
Residence Port (CH)	Residence Tokyo (J)	Residence Bedford (GB)	Residence Kuala Lumpur (MAL)
Height 1.72 m	Height 1.84 m	Height 1.78 m	Height 1.83 m
Weight 62 kg	Weight 74 kg	Weight 71 kg	Weight 74 kg
Facebook NeelJaniRacing	Facebook alotterer	Facebook NickTandyRacing	Facebook earlbambermotorsport
Twitter @neeljani	Twitter @Andre_Lotterer	Twitter @NickTandyR	Twitter @earlbamber
Website neel-jani.com	Website andre_lotterer		Website earlbambermotorsport.com
Instagram neeljani_official			Instagram earlbamber
			Facebook timobernhard.de
			Twitter @timo_bernhard
			Website timo-bernhard.de
			Instagram timobernhard
			Facebook BrendonHartleyMotorsport
			Twitter @BrendonHartley
			Website brendonhartley.co.nz
			Instagram brendon_hartley



World *tour*

Nine times the 2017 WEC was racing during its journey around the globe. Info, statistics and stories about the events and a look at mobility conditions at the venues

Metropolis

with a pioneering role

London has a tradition of innovative concepts in passenger transportation. The capital of the United Kingdom is well prepared for the future too

Made in Britain Typical London landmarks include the London Eye Ferris wheel, the Thames and Big Ben

January 10, 1863 marked the day of the “maiden voyage” of the London Underground, the first subway system of its kind in the world. Ever since then, the “Tube” has been an indispensable element of the public transit systems in London, which is located some 90 kilometers southeast of the WEC venue of Silverstone. Nearly 1.4 million people per day use the Tube’s eleven lines that, with a route length of 402 kilometers, form the largest network in Europe and, after Shanghai and Beijing, the third-largest in the world.

But London has not only been innovative in terms of routing and directing traffic with respect to its subway system. To prevent gridlock of urban car traffic and to reduce the environmental burden, the city has been collecting a city toll, called “congestion charge” since 2003. This made London the first metropolis to require urban motorists to pay such a fee. Numerous other big cities have since followed the British example. Covering an area of 22 square kilometers, it’s still the largest city toll zone in the world.

Silverstone 

The “CC” proved a success for a long time, reducing London’s traffic density by a third right in the first year. However, due to the rapid growth of the metropolis, the pre-CC state has been reached again. However, there’s a new solution now to counteract poor air quality. On April 8, 2019, London will introduce an “ultra-low emissions zone” that will penalize drivers of motor vehicles with high emissions by charging them additional fees. The objective is to restrict traffic in the heart of London to zero- or low-emissions vehicles.

Trendsetter in automated driving

There’s another idea that London’s city government is aiming to emphasize its pioneering role in innovative transportation concepts with starting in 2019. Thanks to a new policy, self-driving cars will be allowed on public roads for testing without a human having to supervise the technology. From 2021 on, autonomous vehicles are planned to travel on British roads without any limitations. ■

33 km/h

This is the average speed of the London Underground

8.8

million people live in London – making the city the biggest metropolis in the EU. Ranked in second place, Berlin has “only” 3.6 million residents



A good *beginning*

“I really had fun driving”

#1 Nick Tandy



For the first time after entering the WEC in 2014, Schaeffler and Porsche compete with new regular drivers at Silverstone. Neel Jani/André Lotterer/Nick Tandy compete in the number 1 919 Hybrid and Earl Bamber/Timo Bernhard/Brendon Hartley in the number 2 car. As the regulations only permit two aerodynamic versions anymore for the season Porsche takes a calculated risk in the season opener and races with less downforce than the level that would be ideal for this fast circuit. In qualifying, the two 919 cars secure the second row on the grid and the race even goes better than that. Hartley leads in the final stage and is only bumped from position one seven laps before the finish. His teammates in the other car occupy position three.



“We can definitely be very pleased”

#2 Brendon Hartley



60-70

percent of the Porsche 919 Hybrid were newly developed for 2017



Race

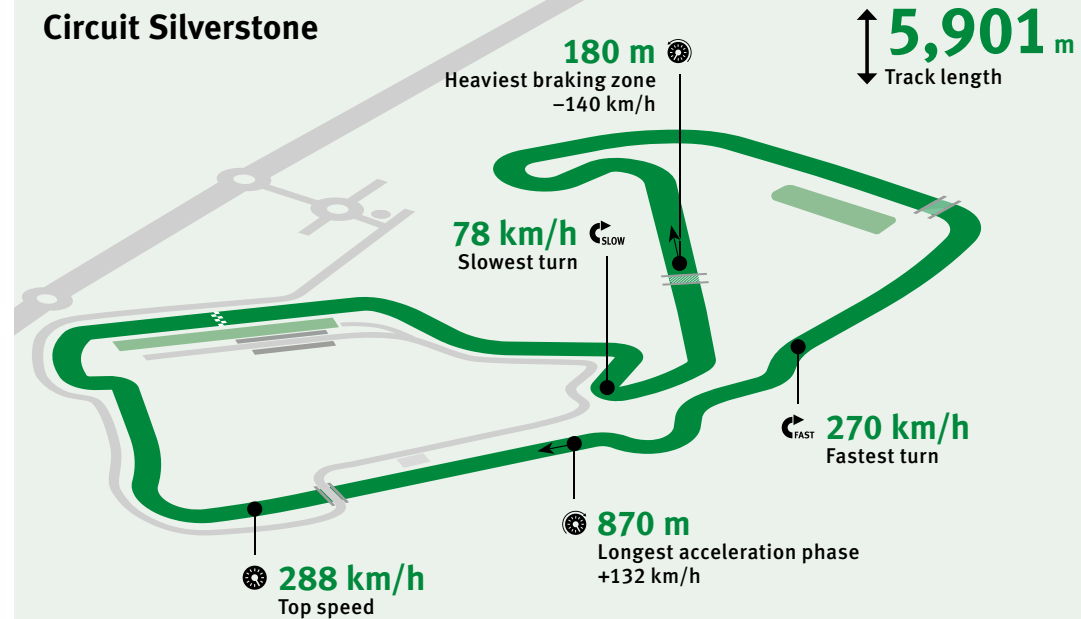
P	Drivers	Time
1	Buemi/Davidson/Nakajima	6h 00m 33.211s
2	Bamber/Bernhard/Hartley	+6.173s
3	Jani/Lotterer/Tandy	+46.956s
4	Tung/Jarvis/Laurent	-13 laps
5	Canal/Prost/Senna	-13 laps
6	Perrodo/Vaxiviere/Collard	-13 laps
7	Lapierre/Menezes/Rao	-14 laps
8	Rusinov/Thieriet/Lynn	-14 laps
9	Graves/Hirschi/Vergne	-14 laps
10	Gonzalez/Trummer/Petrov	-15 laps

Laps 197

Pole position Mike Conway/Kamui Kobayashi, 1m 37.304s

Fastest race lap Mike Conway, 1m 39.656s

Circuit Silverstone



Gaining *ground*

E-mobility is playing an increasingly important role in Belgium even though the development is split in two

Eye-catcher The Cathedral of our Lady stands out in the big Belgian city of Antwerp

In Belgium, electric vehicles have been gaining ground, with a consistently growing number of registrations in recent years. On August 1, 2017, the 10,000-mark of registered vehicles was surpassed for the first time, equating to a fourfold increase since 2012. However, this development is split in two, primarily encompassing Flanders, the wealthier, Dutch-speaking part of Belgium. The reason is that the local energy minister, Bart Tommelein, has made a total of five million euros available for use as incentives for buyers of electric cars, which may amount to as much as 5,000 euros per vehicle. In addition, electric vehicles have been exempt from road tax in Flanders since 2016. The network of battery charging stations is being expanded as well to boost sales. Currently, there are about 250, nearly a third of which are found in the capital, Brussels. The growing importance of

electric mobility is reflected at Audi's site in Brussels as well. At the brand's Belgian plant, the e-tron model will be produced from 2018 on and the e-tron Sportback starting in 2019. These are the first fully electric Audi models.

Innovative solar tunnel

A clever idea that has been used for renewable energy production since 2011 made headlines in Belgium. Above the high-speed train track between Brussels and Amsterdam a 3.6-kilometer tunnel was built with 16,000 solar cells installed on its top. Since then, the train track has not only been protected against falling trees but also producing 3,300 MWh of electricity which equates to the consumption of 1,000 households. Thanks to the 14.5-million euro project, about 47.3 million kilograms of CO₂ emissions are supposed to be avoided over a period of 20 years. ■

335,000

lamps illuminate Belgian freeways at night

68

kilometers. This is the length of the Belgian coastal tram that has a total of 69 stops



Difficult
“dress rehearsal”

The 6-hour race at Spa-Francorchamps is traditionally the last race before the WEC season’s pinnacle event at Le Mans. The two Porsche 919 Hybrid cars demonstrate their potential on the legendary Belgian race track but incidents in the race cost valuable time. The trio of Earl Bamber, Timo Bernhard and Brendon Hartley loses ground due to a slow puncture and a change of the hood following a collision and takes third place. Hartley, though, achieves the fastest race lap. The sister car driven by

Neel Jani, André Lotterer and Nick Tandy which started from pole position is slowed by neutralization periods that are unfavorable for the race tactics and has to settle for fourth place. ■

“We were unfortunate due to the timing of the neutralization periods and lost a lot of time in the process”

#1 Neel Jani



100

meters. This is the vertical difference on the “Ardennes roller coaster” at Spa

May 6, 2017

Spa-Francorchamps

Race

P	Drivers	Time
1	Buemi/Davidson/Nakajima	6h 00m 11.490s
2	Conway/Kobayashi	+1.992s
3	Bamber/Bernhard/Hartley	+35.283s
4	Jani/Lotterer/Tandy	+1m 25.438s
5	Sarrazin/Kunimoto/Lapierre	-2 laps
6	Webb/Kraihamer/Rossiter	-12 laps
7	Rusinov/Thieriet/Lynn	-13 laps
8	Canal/Prost/Senna	-13 laps
9	Tung/Jarvis/Laurent	-13 laps
10	Beche/Heinemeier Hansson/Piquet	-14 laps

Laps 173

Pole position Neel Jani/André Lotterer, 1m 54.097s

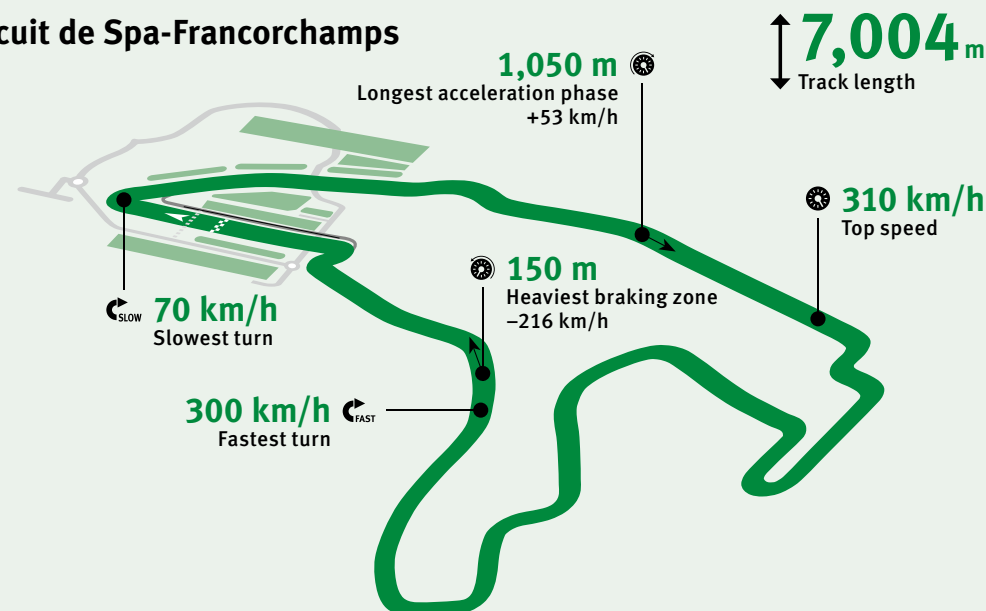
Fastest race lap Brendon Hartley, 1m 57.638s

“We’re traveling to Le Mans with optimism”

#2 Brendon Hartley



Circuit de Spa-Francorchamps



Le Mans

A legend in transformation

The historic city south of Paris has had the worldwide ring of motorsport to its name since 1923, and is currently in the process of getting ready for the mobility of tomorrow: on rails

A population of 150,000. In 21st place of France's most populous cities. The fame of Le Mans could be assumed not to be much greater than that of Paderborn, its German sister city, if it weren't for this one uniquely gripping race that electrifies the entire motorsport world: the 24 Hours of Le Mans. Since 1923, the city has been transforming into a mecca for some 265,000 motorsport fanatics. For more than a week in the month of June, condi-

tions in the city are exceptional. Over the past nearly 100 years, Le Mans has evolved into a synonym for reliability related to the automotive industry and motorsport. Particularly for manufacturers with commitments in sports car endurance racing, the 24 Hours of Le Mans not only marks the pinnacle of racing, but an event where prestige is at stake: will the technology that months of fine-tuning work have been invested in pan out?

Over 100 *historic race cars are displayed at the "Musée des 24 Heures du Mans"*

3

production sites and a research and development center are operated by Schaeffler in France

Taking a plane to the local Aéroport du Mans or the TGV train are good ways to travel to the super event. Le Mans has been connected to the French high-speed train network since 1989.

Inside the city, residents and tourists can superbly get around on rails as well. Since 2007, Le Mans has had a modern streetcar system called the Tramway du Mans. The north-south route covers more than 15 kilometers from Université to Antarès and in 2014, another line was opened that serves the north-eastern part of the city. The operator, Société des transports en commun de l'agglomération mancelle (SETRAM), today enjoys some 50,000 passengers per day, which, in view of the population only being about three times this number, is amazing. These figures clearly prove that urban residents are definitely inclined to give preference to public transportation over their personal cars.

This is a trend that can be seen in other French cities as well. Strasbourg, Nantes and Bordeaux have had modern streetcar networks for quite some time. Valenciennes, Mulhouse and Saint-Etienne have recently followed suit, and Nice, Marseille and Grenoble are going to do so as well.

A city uses new approaches

Attracting major public attention, Paris inaugurated a brand new streetcar line as well at the end of 2016. The French capital in particular was in need of another public transportation alternative to its Métro. The "city of love" has been suffering from the threat of passenger car traffic collapsing for many years. As recently as last year, a cloud of smog engulfed the metropolis which made alarm bells ring especially with Anne Hidalgo. The mayor of Paris is personally endeavoring to declare war on automobile mania with various projects and to provide more room to "her" pedestrians and cyclists. ■

Fan magnet Place des Jacobins in Le Mans is the venue of the driver parade



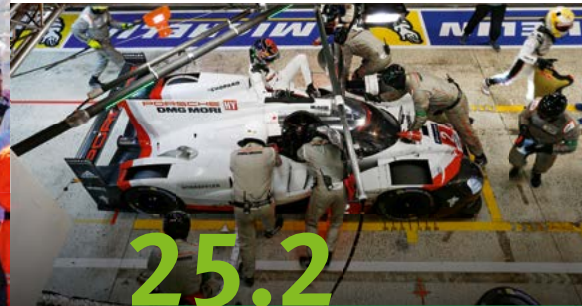
R 3



Sensational fightback

June 17/18, 2017

Le Mans



25.2
gigabytes of data are transmitted from the winning car to the pits during the 24 hours

“I can’t believe that we managed to turn this race”

#2 Earl Bamber



Le Mans 2017 goes down in racing history, the two Porsche 919 Hybrid cars being the principal performers. The race is totally under the banner of Toyota all the way into the night, but then car number 1 takes the lead for the next ten hours – until a defect ruins all hopes of victory. This is the hour of the sister car which had no front wheel propulsion anymore three-and-a-half hours into the race and had dropped to position 54 due to a repair that cost 19 laps. Bamber/Bernhard/Hartley subsequently show a breath-taking fightback. Following their teammate’s retirement, they’re already in position two. 20 laps before the finish, they take the top spot from the leading LMP2 car and, after 2015 and 2016, achieve a hat-trick for Schaeffler and Porsche at Le Mans.



“Retiring is bitter. That’s Le Mans”

#1 André Lotterer

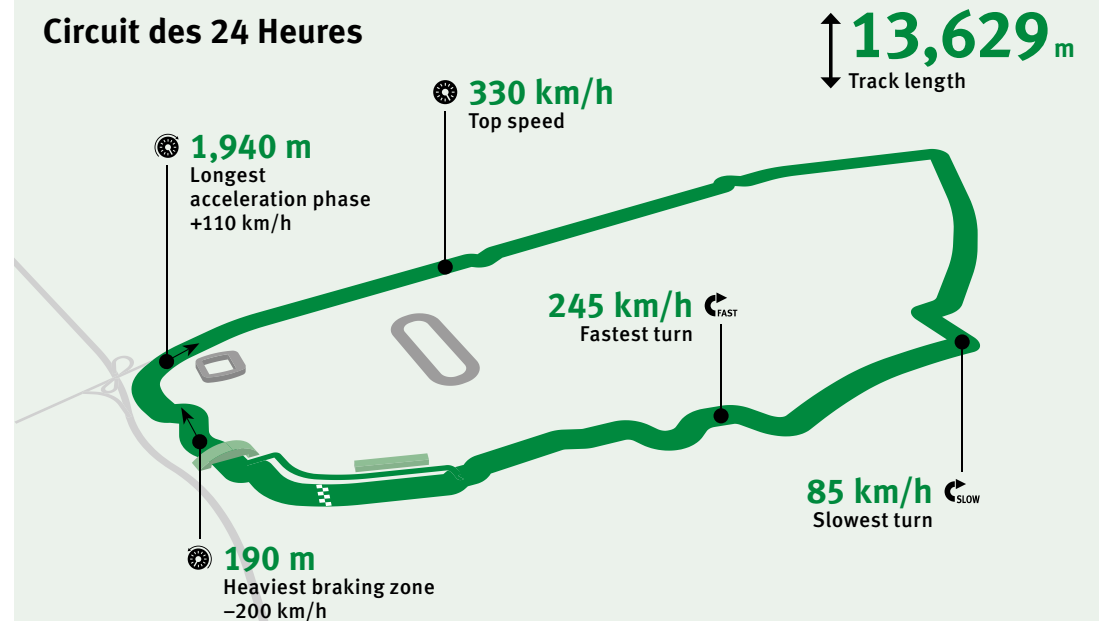


Race

P	Drivers	Time
1	Bamber/Bernhard/Hartley	24h 01m 14.075s
2	Tung/Jarvis/Laurent	-1 lap
3	Cheng/Gommendy/Brundle	-4 laps
4	Panciatici/Ragues/Negrão	-5 laps
5	Owen/De Sadeleer/Albuquerque	-5 laps
6	Allen/Matelli/Bradley	-6 laps
7	Graves/Hirschi/Vergne	-7 laps
8	Buemi/Davidson/Nakajima	-9 laps
9	Lacorte/Sernagiotto/Belicchi	-14 laps
10	Dumas/Menezes/Rao	-16 laps

Laps 367
Pole position Kamui Kobayashi, 3m 14.791s
Fastest race lap Sébastien Buemi, 3m 18.604s

Circuit des 24 Heures



Prestige aplenty

The Nürburgring is not just one of the world's major race tracks, but also an important proving ground for automobile manufacturers and suppliers



Nürburgring 

€25

is the rate a private citizen pays for driving on the Nordschleife during the week

6m 11.13s

is the lap record for race cars on the Nordschleife – posted by Stefan Bellof in a Porsche 956 C in 1983

Nearly 21 kilometers long, 73 turns, gradients of up to 18 percent – the Nürburgring Nordschleife is unique in many respects and rightfully referred to as the most challenging, awe-inspiring and simply the world's best permanent race track by many international special-interest magazines. But there's even more to the Nürburgring than this. To production vehicle manufacturers, the circuit in the Eifel region provides an important opportunity for testing new models due to its varied characteristics.

Blind corners and treacherous crests, steep uphill and downhill gradients, plus frequently changing track surfaces, put drivers and vehicles through their paces: the Nordschleife mythos. Due to its huge dimensions,

it's not uncommon for some of the race track's sections to see stormy weather and sunshine in others at the same time. And towering above it all is the Nürburg fortress that has given the circuit its name.

Ever since its inauguration in 1927 bold men and women have been pitted against each other in motorcycle and car races on the Nordschleife. 1951 was the first year to see a Formula 1 event being held on a version of the track that was still nearly 23 kilometers long at the time. In 1968, the subsequent three-time F1 World Champion Jackie Stewart nicknamed the race track "Green Hell" – a term that has since become a synonym for it. An event that was to evolve into a classic is the 1,000-kilo-



meter race at the Nürburgring that was part of the World Sportscar Championship for more than 40 years. Porsche clinched eleven overall victories in it, including successes with models as legendary as the Porsche 908/03 Spyder in 1971 (large picture).

Today, the Nordschleife is no longer approved for any racing series with vehicles reaching speeds beyond 300 km/h. That's why the FIA World Endurance Championship (WEC), in which Schaeffler's partner Porsche competes with two 919 Hybrid prototypes in the top LMP1 category, holds its 6-hour race "only" on a partial section, the Grand Prix circuit with a length of about 5 kilometers that was opened in 1984 (small picture).

Competition of the manufacturers

But the Nürburgring is not only a venue for motor racing's competitive events, as the circuit has long been discovered by automotive OEMs and suppliers as a gauge for the reliability of their latest products as well. Practically no road-going car goes into mass production without previously having passed the Nordschleife endurance test. And even here a serious competition has by now emerged. Manufacturers pride themselves on setting new lap records. In 2013, Porsche factory driver Marc Lieb in a 918 Spyder was the first to break the seven-minute "sound barrier." ■

Eifel *hat-trick*



“Our car could have won as well, but we performed teamwork”

#1 André Lotterer

3 victories in succession have been clinched by Porsche at the Nürburgring. As a result, the brand remains unbeaten

Race

P	Drivers	Time
1	Bamber/Bernhard/Hartley	6h 00m 09.607s
2	Jani/Lotterer/Tandy	+1.606s
3	Conway/Kobayashi/Lopez	+1m 04.768s
4	Buemi/Davidson/Nakajima	-5 laps
5	Tung/Jarvis/Laurent	-13 laps
6	Canal/Senna/Albuquerque	-14 laps
7	Lapierre/Menezes/Rao	-14 laps
8	Beche/Heinemeier Hansson/Derani	-14 laps
9	Cheng/Brundle/Gommendy	-15 laps
10	Rusinov/Thiriet/Hanley	-16 laps

Laps 204

Pole position Kamui Kobayashi/José Maria Lopez, 1m 38.118s

Fastest race lap Kamui Kobayashi, 1m 40.633s

July 16, 2017

Nürburgring

A small jubilee for Schaeffler and Porsche at the Nürburgring: In the round on home soil, their 15th WEC victory in total is achieved by Bamber/Bernhard/Hartley. Their teammates, Jani/Lotterer/Tandy, complete the one-two triumph in the Eifel. Porsche in round four of the season uses the high-downforce aerodynamics package for the first time – and it pays

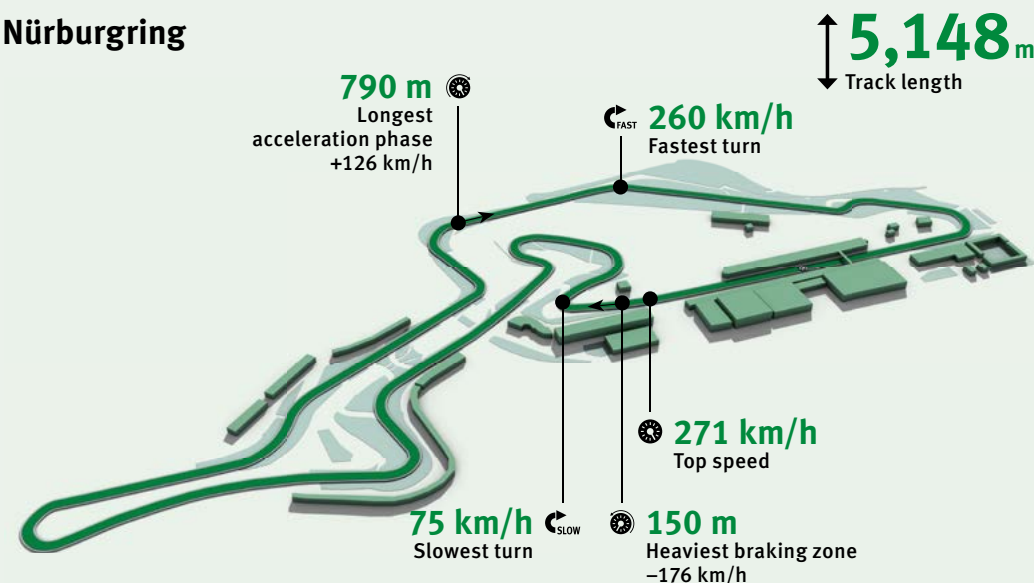
off. Following grid positions two and three, the two 919 Hybrid cars are the measure of all things in the 6-hour race. Both cars are running in front some of the time during the race. When the checkered flag falls the sports prototypes from Stuttgart are separated by only 1.6 seconds – led by the WEC front runners in car number 2.

“A one-two result in a home race is a fantastic result”

#2 Timo Bernhard



Nürburgring



A picturesque view Behind the skyline of Mexico City towers the mighty Popocatepetl volcano

Creative minds needed

In terms of mobility, there's one thing that prevails in Mexico City – chaos. But there's hope: initial strategies are beginning to alleviate the megacity's major problem

6 km/h

is the average speed at which vehicles travel on major traffic arteries during rush hour in Mexico City

3

Schaeffler has **3** production sites in Mexico. The most recent one in the state of Puebla was inaugurated at the end of 2015

320

There are **320** vehicles per 1,000 residents in Mexico City. At the moment, the registration rate of new vehicles is twice as high as the birth rate

Mexico City 

José Castillo once described the urban portrait of Mexico City as huge, looking pretty chaotic and certainly being selfish. The Mexican Harvard professor is a renowned expert in the fields of urban planning and mobility. Together with his team he has developed a system that gathers and analyzes real-time traffic data in Mexico City.

But in the case of Mexico City, a single good idea is not enough. 20 million people live in the metropolitan area and nearly nine million in the core of the city. More than four million passenger cars, 120,000 taxis, 28,000 buses and tens of thousands of trucks travel daily in and around Mexico's capital – these are the facts. And the result: It takes the 300,000 commuters nearly three hours per day to get to work in the business districts, according to the "IBM Commuter Pain Index." This means every one of them spends about a month per year caught in a traffic jam. There are no alternatives to passenger cars available to commuters. As a result of the privatization of the Mexican railroad system, service on all passenger train lines from and to Mexico City was discontinued in 1996.

By contrast, the situation in the center looks better. Local residents and tourists can choose

from a variety of options available in a well-developed public transit system: radio taxis, buses or the metro with a total of 195 stations.

Unusual approaches

So, what options are available now to master the great chaos? According to José Castillo, there is no single, all-encompassing solution, as mobility is made up of numerous factors for which equally diverse solutions must be found and coordinated. A very creative project was launched last year. The nearly five kilometer long cable car service "El Mexicable" with its two cableways and 190 cars carries some 3,000 passengers per hour across Ecatepec de Morelos, one of the most populous districts of Mexico City. Whereas other big cities are on a desperate hunt for additional parking space, Mexico City has more than enough. The total of 6.5 million parking places for passenger cars account for 42 percent of the entire developed area. The government now intends to reduce them, particularly at locations where public transit has been well-developed. ■

Dominance in Mexico



“Toyota didn’t have the slightest chance today”

#1 Neel Jani



Round five of the season marks the WEC’s departure from Europe and the start of its overseas stage in Mexico City. At the round in the Central American metropolis, Schaeffler and Porsche are racing in a class of their own. In qualifying, the 919 Hybrid cars secure the two top spots on the grid. In the race, the two hybrid sports cars never relinquish the lead and clinch the second one-two result in succession. The two Toyota cars that finish in positions three and four are even lapped. Victory again goes to Bamber/Bernhard/Hartley who started from pole position. Their teammates see the checkered flag with a 7.1-second deficit in second place after having to sit a drive-through penalty in the race.



“We were able to control the race and didn’t have to take any great risks”

#2 Brendon Hartley



Race

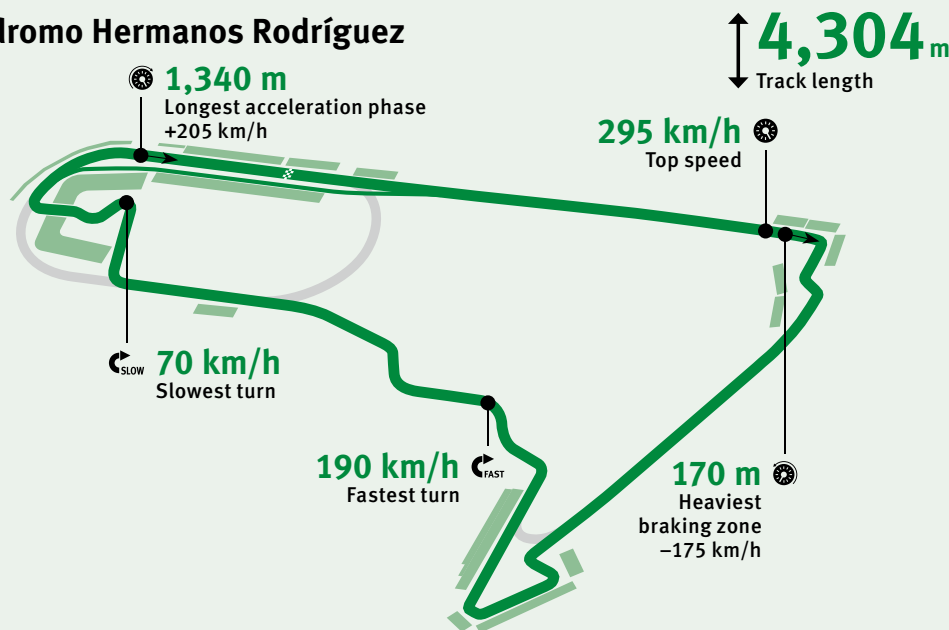
P	Drivers	Time
1	Bamber/Bernhard/Hartley	6h 00m 05.757s
2	Jani/Lotterer/Tandy	+7.141s
3	Buemi/Davidson/Nakajima	-1 lap
4	Conway/Kobayashi/Lopez	-1 lap
5	Canal/Prost/Senna	-21 laps
6	Lapierre/Menezes/Negrão	-21 laps
7	Rao/Hanley/Vergne	-21 laps
8	Rusinov/Thieriet/Lynn	-21 laps
9	Beche/Heinemeier Hansson/Piquet	-22 laps
10	Cheng/Brundle/Gommendy	-22 laps

Laps 240
Pole position **Timo Bernhard/Brendon Hartley**, 1m 24.562s
Fastest race lap **Brendon Hartley**, 1m 25.730s

2,285

meters above sea level – this is the elevation of the circuit in Mexico – higher than that of any other

Autódromo Hermanos Rodríguez



Austin at night View of the U.S. metropolis across the Colorado River

“Autos city” Austin

In Austin, the automobile – like in most North American regions – is an indispensable means of transportation. Alternatives are in scarce supply but urgently needed to relieve the burden on chronically congested streets

8

production sites and three research and development centers are operated by Schaeffler in the United States

201 million

U.S. dollars per year are spent by the state of Texas on transportation projects in Austin. Still, the traffic situation in the city has recently been rated as the tenth worst in all of the United States by Texas A&M University

Those who would like to catch a whiff of U.S. big city atmosphere off the Circuit of The Americas, the venue of race six of the FIA World Endurance Championship (WEC) season, should take a side trip to Austin which is about 30 kilometers away. However, it is advisable to rent a car for this purpose, not only to get from the race track to Austin, which has a population of 950,000, but also to get around the city itself. Like in most places in the United States, cars are the number one means of transportation here. 73 percent of all the people working in Austin use their privately owned vehicles to commute and ten percent use carpools.

Only five percent of the two million residents in the metropolitan area use locally available mass transit, which in Austin is essentially limited to a heavily frequented means of trans-

portation: the bus. The Capital Metropolitan Transportation Authority operates 82 bus lines carrying some 2.2 million passengers per month between 2,700 stops. By contrast, the “Capital MetroRail” is a rather unusual form of mass transit in Austin. The above-ground streetcar has only one line hauling 60,000 people per month.

Leaving the car at home for a change

Don’t feel like struggling with traffic jams or taking a bus? If so, then Austin is a great place for using a bicycle to get from A to B. 130 kilometers of bicycle paths meander through Austin – which is pretty much for a big U.S. city. The internationally acclaimed “Bicycling” magazine has listed Austin as the seventh most bicycle-friendly city in the United States. “Forbes” magazine even ranks Austin in third place of this category behind Philadelphia and Tucson. ■



A battle in the
heat

33

degrees and 40 degrees – those were the air and track temperatures during the race at Austin

Race

P	Drivers	Time
1	Bamber/Bernhard/Hartley	6h 00m 52.444s
2	Jani/Lotterer/Tandy	+0.276s
3	Buemi/Davidson/Nakajima	+21.956s
4	Conway/Kobayashi/Lopez	+45.026s
5	Lapierre/Menezes/Negrão	-15 laps
6	Beche/Heinemeier Hansson/Piquet	-16 laps
7	Canal/Prost/Senna	-16 laps
8	Tung/Jarvis/Laurent	-16 laps
9	Cheng/Brundle/Gommendy	-17 laps
10	Rao/Hanley/Vergne	-17 laps

Laps 192
Pole position **Neel Jani/Nick Tandy, 1m 44.741s**
Fastest race lap **Neel Jani, 1m 47.149s**

“That was quite a battle today”

#1 André Lotterer



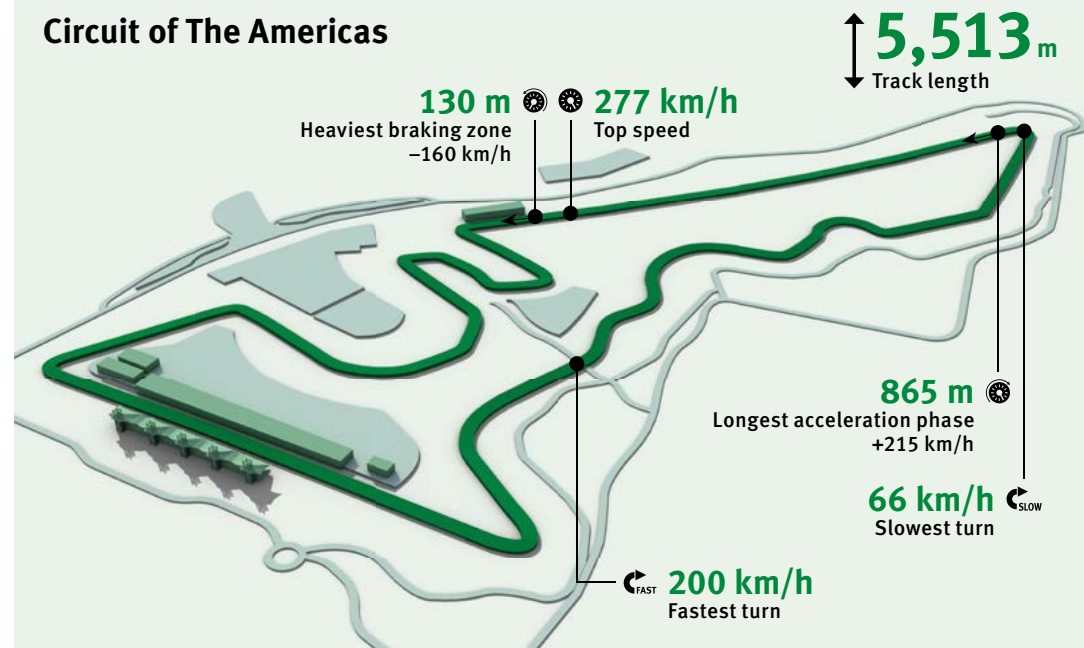
It's arguably the season's hottest race: the sixth WEC round on the Circuit of The Americas. In temperatures of more than 30 degrees centigrade, the action on track is red-hot as well. The two Porsche that have started from the front row and the two Toyota fight numerous action-packed position battles in which the LMP1 sports cars even touch each other now and then. The lead changes a total of five times. The Porsche of Jani/Lotterer/Tandy that started from pole has been on course for victory for a long time before, in a highly thrilling final stage four laps before the finish, the Briton lets the sister car of Bamber/Bernhard/Hartley that's in a better position in the WEC standings pass. This car ultimately leads the third one-two win in succession for Schaeffler and Porsche.

“Our sister car pushed us to the limits”

#2 Earl Bamber



Circuit of The Americas



E-mobility has a *high* priority

Japan achieved a top position in the electric mobility market many years ago and has maintained it ever since

Landmark Fuji Speedway is named after Japan's highest mountain, Mount Fuji (in the background). Shown in front is Tagonoura Port

Fuji 

The “land of the rising sun” is strong in electric mobility both in terms of batteries and in the segment of all-electric and hybrid electric vehicles. The first commercially available lithium-ion battery was produced by Japan's electronics giant Sony in 1991. Initially used primarily in mobile devices with high power consumption such as cell phones and digital cameras, the lithium-ion battery today also serves as an energy storage device in electric mobility, for pedelecs, electric cars, modern electric wheel chairs and hybrid electric vehicles for example. All major automobile manufacturers from Mitsubishi and Toyota to Nissan and Honda offer battery-powered electric vehicles.

There are many reasons for Japan's success in this forward-thinking sector. One of them is that the country does not have any natural resources to speak of and, as a result,

began to explore the use of alternative energies early on. The government funds electric mobility research and development. In addition, most of the 126 million inhabitants have a strong sense of environmental responsibility and an open mind for new technological achievements. Unlike in Germany, electric vehicles – due to the scarcity of parking spaces – are not primarily used in big cities, but in rural areas and by commuters to make their train connections.

Interurban expansion

Japan is also a pioneer in modern high-speed train technology. The “Shinkansen” high-speed train network that has existed since 1964 is currently being expanded by a maglev train line from Tokyo to Osaka, the completion of which is expected by 2045. The total costs for the “Chūō-Shinkansen” mammoth project amount to some 70 billion euros. ■

505 km/h

will be the speed of the new maglev train Chūō-Shinkansen

337

people live in an area of one square kilometer in Japan – making the country one of the most densely populated in the world

Tricky fountains



“I’ve never experienced a race like this before”

#1 Neel Jani



Race

P	Drivers	Time
1	Buemi/Davidson/Nakajima	4h 24m 50.950s
2	Conway/Kobayashi/Lopez	+1.498s
3	Jani/Lotterer/Tandy	+2.272s
4	Bamber/Bernhard/Hartley	-1 lap
5	Canal/Prost/Senna	-3 laps
6	Lapierre/Menezes/Negrão	-3 laps
7	Tung/Jarvis/Laurent	-3 laps
8	Perrodo/Vaxiviere/Collard	-3 laps
9	Rao/Hanley/Vergne	-3 laps
10	Rusinov/Thiriet/Rossiter	-3 laps

Laps 113
 Pole position **Earl Bamber/Brendon Hartley**, 1m 35.160s
 Fastest race lap **Earl Bamber**, 1m 37.702s

7 days after Fuji, Brendon Hartley celebrates his Formula 1 debut in the United States Grand Prix

“Visibility was extremely poor. I couldn’t see anything anymore”

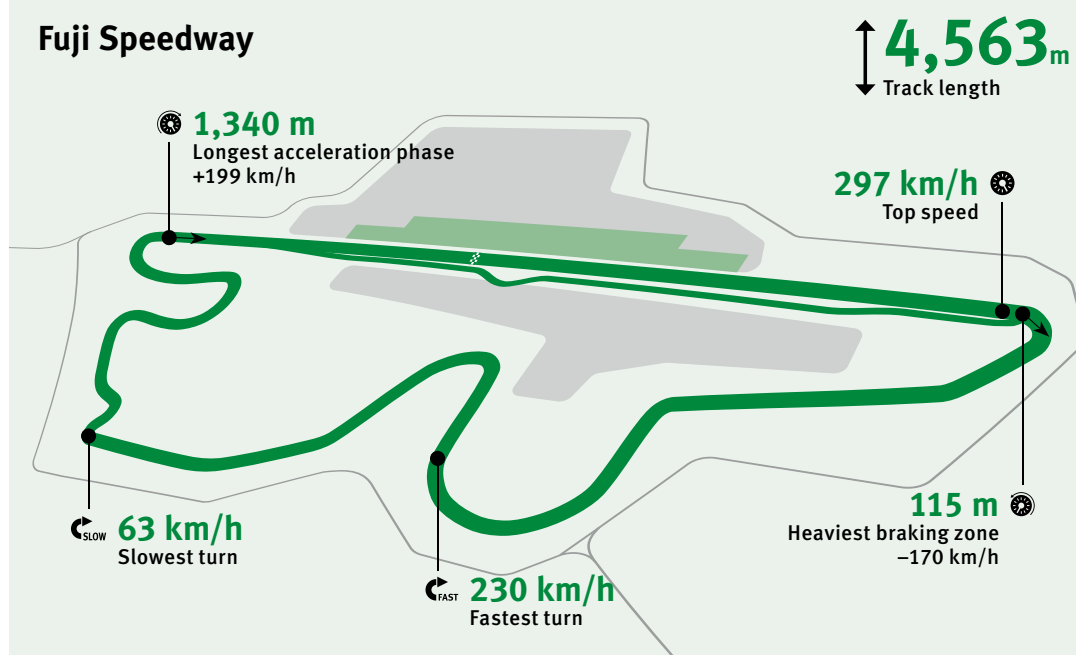
#2 Earl Bamber



Round seven at Fuji packs a punch. As is often the case on this Japanese race track adverse weather makes for unpredictable conditions. The race is already started behind the safety car which is subsequently deployed on several other occasions during the race due to rain, fog and accidents. After 39 laps, the race is even interrupted. Both Porsche cars are leading some of the time but, due to a change of the hood (No. 1) and the safety car periods that don’t fit the race strategy, lose their chances for victory. When the race is finally stopped, they’re in positions three and four.



Fuji Speedway



Under control

In spite of a huge population, traffic literally flows smoothly in the megacity of Shanghai thanks to a number of innovative ideas

With 24 million people living in the metropolitan area, Shanghai is one of the world's top ten most populous cities. Within China, the megacity is even ranked in front of Beijing. A large population often entails major problems in terms of managing the existing infrastructural conditions as well. Ensuring that traffic flow is pleasant for everyone poses a huge challenge particularly in cities with several million residents.

Shanghai can be called a role model in terms of mobility. With two airports, four central train stations and the world's largest container port, the city is in a perfect position with respect to interurban transportation. The intra-urban alternatives leave nothing to be desired either. The metro system with 14 lines is clean, arrives on time and, in contrast to counterparts such as the one in Tokyo, offers ample space for passengers. The means of payment is a re-chargeable magnetic cash card that is valid for other public transit systems as well. The bus network is carefully mapped and, depending on the line, includes vehicles of various sizes and forms – from obsolete vans through to luxury tour buses.

Especially to Europeans, passenger car traffic presents an equally unusual and spectacular sight: six-lane elevated expressways meander through the city, on several levels in some cases, reminiscent of visions of the future known from science fiction movies.

Surprising success

Between high tech and high speed, a completely silent idea is currently celebrating an unexpected breakthrough in Shanghai: bike sharing. More and more residents are opting for this still relatively new form of locomotion. In the past twelve months, thousands of two-wheelers were distributed within the city. They are intended to relieve the nervous strain of traffic participants and – obviously – the burden on the environment. Contrary to many concerns, response by the population to the rental bikes has been excellent. The benefits are clear: easy app-based rental, low rental fees and – something that only very few big cities offer – flexible parking of the bikes, not only at docking stations. The value of the currently largest rental bike provider, Ofo, has already been assessed to amount to more than one billion dollars. ■

11,000

people are employed at the Schaeffler Greater China branch located in Shanghai

13 cents

per hour is the rental fee charged for bikes by the largest provider, Ofo



Goal achieved

“The second WEC title is awesome. I can’t even find any words for that”

#2 Timo Bernhard



Race

P	Drivers	Time
1	Buemi/Davidson/Nakajima	6h 00m 40.777s
2	Bamber/Bernhard/Hartley	-1 lap
3	Jani/Lotterer/Tandy	-1 lap
4	Conway/Kobayashi/Lopez	-7 laps
5	Canal/Prost/Senna	-12 laps
6	Lapierre/Menezes/Negrão	-12 laps
7	Beche/Heinemeier Hansson/Piquet	-13 laps
8	Tung/Jarvis/Laurent	-13 laps
9	Gonzalez/Trummer/Petrov	-13 laps
10	Perrodo/Vaxiviere/Collard	-13 laps

Laps 195

Pole position Mike Conway/Kamui Kobayashi,

1m 42.832s

Fastest race lap Sébastien Buemi, 1m 45.892s



“Congratulations to our three colleagues on clinching the drivers’ title”

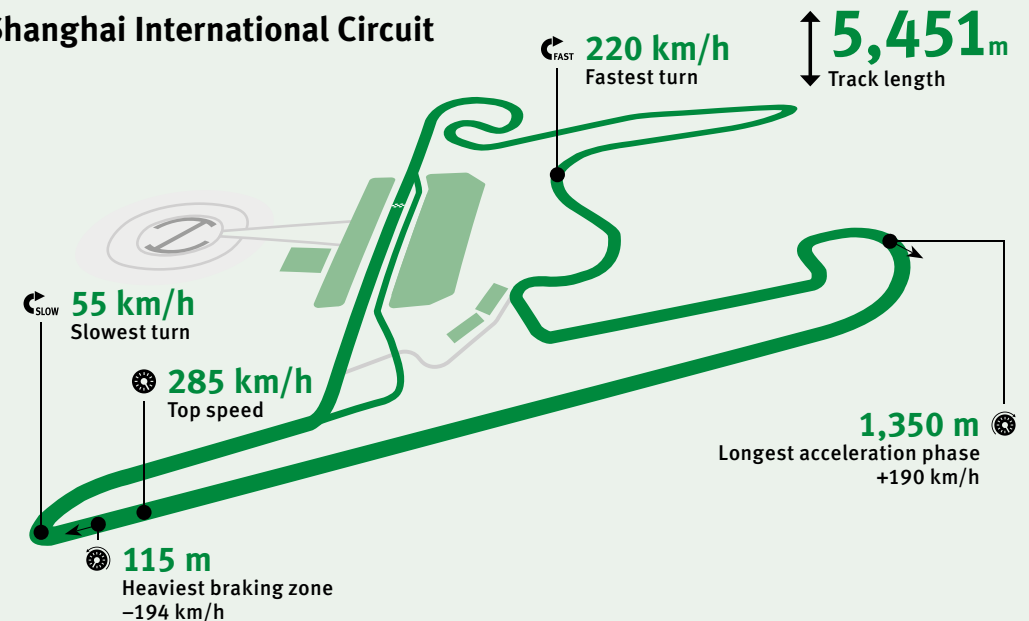
#1 André Lotterer

It’s a done deal! Schaeffler and Porsche secure an early manufacturers’ and drivers’ World Endurance Championship win in the penultimate round of the season at Shanghai. Following the successes in 2015 and 2016, the title hat-trick has been achieved for the first time in WEC history. The trio of Bamber/Bernhard/Hartley in its Porsche 919 Hybrid starts from position four and ultimately clinches second place – and with that it’s clear that the drivers’ title can no longer be taken away from them at the finale in Bahrain. Their teammates, Jani/Lotterer/Tandy, are initially in position two but lose ground following a sensor issue and see the checkered flag in third place.



2 WEC titles: Timo Bernhard and Brendon Hartley are the first WEC double champions

Shanghai International Circuit



Mono mobility

Local public transportation was practically unheard of in Bahrain for a long time. Two years ago, a small bus network was established as an alternative to passenger cars

Futuristic View of the skyline of the modern capital city of Manama, with the Bahrain World Trade Center shown at right



350 km/h

This is the speed at which the high-speed train is supposed to travel on the Friendship Bridge being planned between Doha and Manama

US\$ 0.37

This is the cost of a liter of diesel fuel in Bahrain. As a result, the country ranks among the top 15 places with the lowest fuel costs for passenger cars

Bahrain is a very special state. With an area of 750 square kilometers the archipelago in the Persian Gulf is just about as large as Hamburg. Some 160,000 of its 1.5 million inhabitants live in the capital city, Manama, located in the north. Large parts of the rest of the country, particularly the southern half of the main island, consist of desert-like landscapes. Bahrain International Circuit at which the WEC is holding its racing season finale again this year is situated in a very sparsely populated region as well.

Until 1986, Bahrain was only accessible by ship and aircraft. Since then, King Fahd Causeway, a combination of bridges and causeways,

has provided a link between Bahrain and Saudi Arabia. As is typically the case in countries with large petroleum reserves, passenger cars are the number one means of urban transportation.

Until recently, local public transportation in Bahrain essentially consisted only of taxis. Rail transportation, let alone a subway system, does not exist. Then, in spring of 2015, a new public transit system was inaugurated. Kamal bin Ahmed Mohammed, Minister of Transportation and Telecommunications, wanted to offer Bahrain's population and tourists a safe and high-grade alternative to passenger cars and taxis. The network initially encompassed 77 buses

serving 22 routes. The fleet is planned to be expanded to 141 buses in the following years.

Friendship Bridge

In addition to the overseas connection to Saudi Arabia, a link to neighboring Qatar is being planned as well. The Dschisr al-Mahabba (Qatar-Bahrain Causeway, aka Qatar Bahrain Friendship Bridge) with a length of 45 kilometers is expected to become the world's longest bridge. The estimated costs of this project of mammoth proportions, which includes two lanes for automobiles per direction of travel plus train tracks, amount to some three billion euros. Completion is anticipated by 2022. ■

Podium places in the finale



After four successful joint years, Schaeffler and Porsche say goodbye to the WEC in Bahrain. Bamber/Bernhard/Hartley show a strong fightback that's rewarded with position two. In the early stage, Bernhard runs over a bollard. Due to the repair stop, the trio loses nearly one lap but then fights back to the front. Their teammates, Jani/Lotterer/Tandy, start from pole but lose valuable time due to a stop-and-go penalty and a change of the hood. In the end, they finish in position three.



“Being part of this huge project and having the opportunity to work with this outstanding team has been a really fantastic experience”

#1 Neel Jani

Race

P	Drivers	Time
1	Buemi/Davidson/Nakajima	6h 01m 26.294s
2	Bamber/Bernhard/Hartley	-1 lap
3	Jani/Lotterer/Tandy	-1 lap
4	Conway/Kobayashi/Lopez	-3 laps
5	Canal/Prost/Senna	-13 laps
6	Tung/Jarvis/Laurent	-13 laps
7	Beche/Heinemeier Hansson/Piquet	-14 laps
8	Lapierre/Menezes/Negrão	-14 laps
9	Gonzalez/Trummer/Petrov	-14 laps
10	Rao/Brundle/Vergne	-14 laps

Laps 199

Pole position **Neel Jani/Nick Tandy, 1m 39.383s**

Fastest race lap **André Lotterer, 1m 42.862s**

“It’s an honor for me to have been part of this program. I’m going to miss it”

#2 Brendon Hartley



50

percent victory rate: Porsche's LMP team clinched exactly 17 victories in 34 races



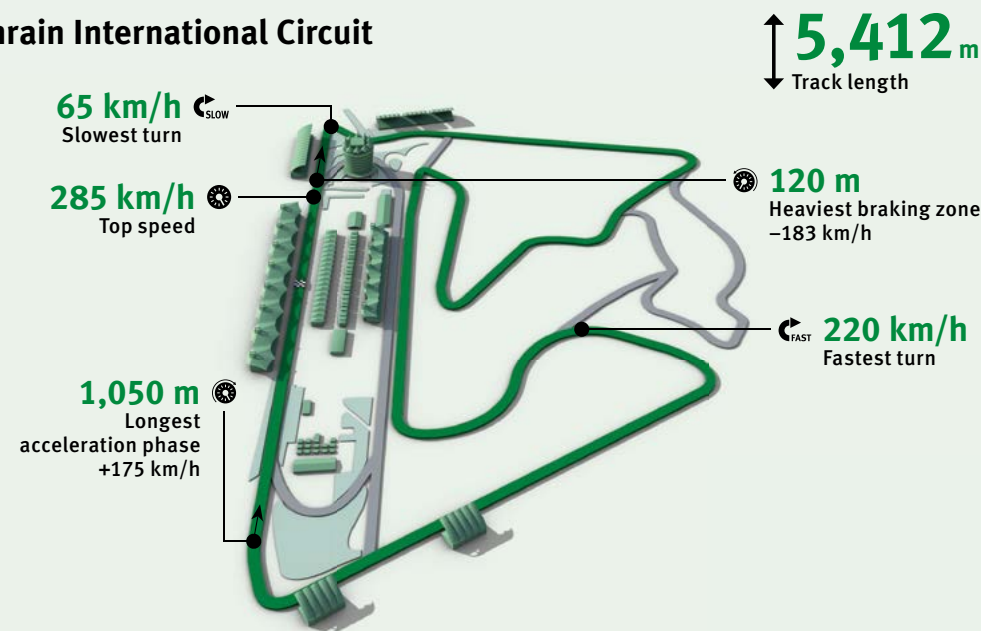
Final drivers' standings

P	Drivers	Manufacturer	Pts
1	Bamber/Bernhard/Hartley	Porsche	208
2	Buemi/Nakajima	Toyota	183
3	Davidson	Toyota	168
4	Jani/Lotterer/Tandy	Porsche	129
5	Conway/Kobayashi	Toyota	103.5
6	Lopez	Toyota	84.5
7	Jarvis/Tung/Laurent	Oreca-Gibson	82.5
8	Canal/Senna	Oreca-Gibson	76
9	Prost	Oreca-Gibson	68
10	Negrão	Oreca-Gibson	62.5

Final manufacturers' standings

P	Manufacturer	Pts
1	Porsche	337
2	Toyota	286.5

Bahrain International Circuit



An electrifying *affair*

The powertrain concept of Porsche's Le Mans hybrid sports car is a forward-thinking one. A turbocharged downsized IC engine together with a powerful electric motor ensures dynamic and efficient propulsion. Schaeffler is developing diverse concepts to put hybrid powertrains on the fast track of everyday mobility as well

The first question to be clarified is the meaning of hybrid in the language of automotive developers. Put in a nutshell, a hybrid complements the conventional IC engine by a second source of propulsion and, today, this refers to electric motors.

One name, various concepts

In the automotive OEM and supplier industries, various hybrid systems are being tested and offered for diverse demands. As a pioneer in this field, Schaeffler possesses a wealth of experience and wide range of systems – see right-hand page. Every one of these innovative and intelligent concepts

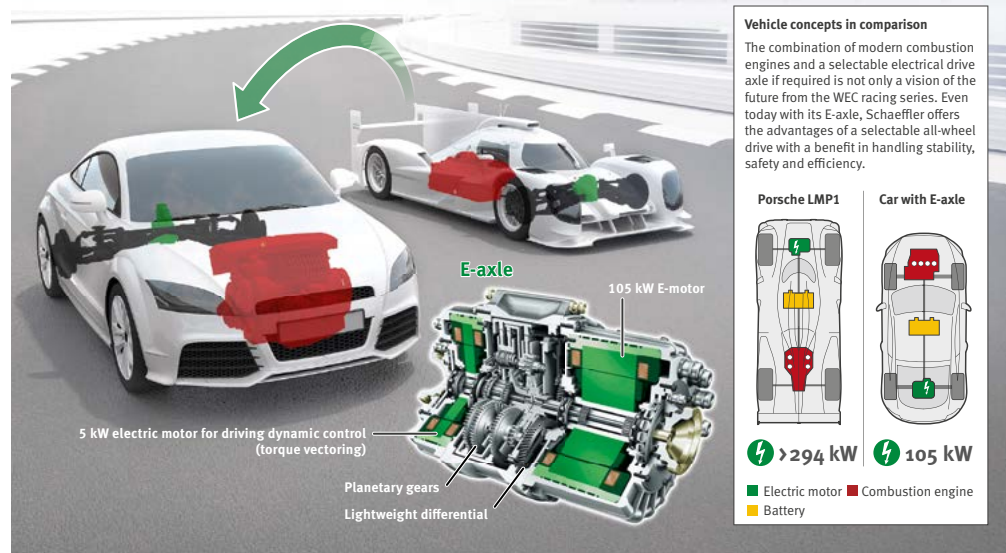
has its justification in the marketplace. Not least due to the fact that “more electricity on board” makes it possible to replace other conventional mechanical or hydraulic components by electric ones.

Optimization in many areas

Obviously, within the Schaeffler Group, the optimization of the IC engine continues to be driven with the same intensity as hybrid technology. In spite of all the progress that has already been achieved, Schaeffler still sees further potential of optimizing the efficiency of IC engines, by 10 percent for diesel and by 20 percent for gasoline engines. ■

ELECTRIC FOUR-WHEEL DRIVE

The connection of the combustion engine with an electric drive provides new opportunities. In motor racing, hybrid cars with four-wheel drive concepts represent the pinnacle of the technically feasible. In conventional road cars, the electrification of the drivetrain with increasing hybridization plays an important role. With its E-axis, Schaeffler provides an innovation that combines the electric drive with the possibility of wheel selective controllable driving power. All-wheel drive in connection with combustion engines is available to the driver when required.



Graphics www.josekdesign.de

5

Comparison of hybrid concepts

Micro hybrid (12 volts)

The principle Micro hybrid refers to vehicles that are equipped with a start-stop system and recuperate braking energy via a generator, in other words, continually charging the battery. The starter-generator – the electric machine – cannot be used for propulsion.

In simple terms The brakes and coasting of the vehicle charge the conventional battery, so the engine no longer has to perform this “job.” This saves fuel, just like the automatically shutting off and turning the engine on again when the vehicle stops, for instance at a traffic light.

Mild hybrid (48 volts)

The principle The electric motor (which may be an electric axle, see info box, Page 14) in the 48-V hybrid assists the conventional IC engine (ICE) with a power boost. Braking energy can be recuperated. Using the 20-kW electric motor, even fully electric driving to a limited extent is an option when the IC engine is disengaged.

In simple terms Less consumption, fewer emissions, more momentum – the “mild” 48-V hybridization yields many advantages from a moderate technology investment.

Full hybrid (> 200 volts)

The principle Functions are similar to those of the 48-volt system. High-voltage technology, though, increases output as well as technology investment. Full hybrid vehicles can optionally be operated in all-electric mode, only using the IC engine or combined.

In simple terms A more powerful battery and a larger electric motor in this type of vehicle enable all-electric driving, albeit, as in the case of the 48-volt system, with shorter range and at lower speed.

Plug-in hybrid (> 200 volts)

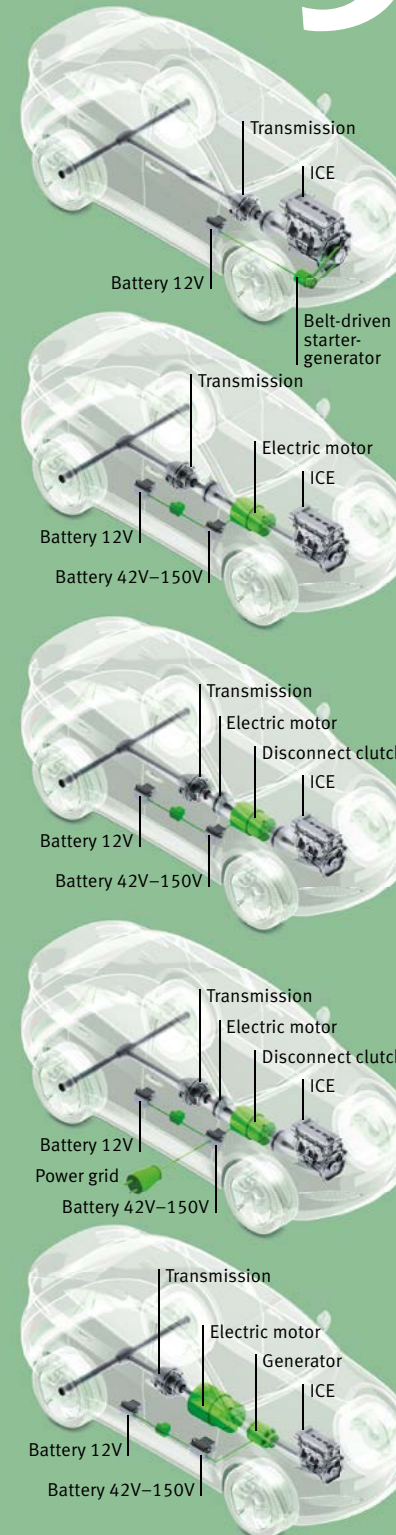
The principle While the battery of a mild or full hybrid is charged exclusively via braking energy or the IC engine, the battery of a plug-in hybrid can additionally be charged externally using the power grid. Therefore, a larger battery is utilized which allows clearly longer ranges to be achieved in electric mode.

In simple terms The battery and electric motor are suitable for mid-range distances and the system can be charged by plugging into a power outlet/charging station.

Range extender (> 200 volts)

The principle Electric vehicles with range extenders have a powerful electric motor and enable all-electric driving over a comparably long range. IC engines are most frequently used as range extenders. They drive a generator which in turn supplies power to the battery and the electric motor.

In simple terms The vehicle operates in fully electric mode. The “small” IC engine merely serves to charge the batteries for the “large” electric motor.





Race track >>> Road

An electric circuit

Motorsport has always been a driver of developments that subsequently make their way into production vehicles. This now applies to electrified powertrains as well. In the FIA World Endurance Championship (WEC) with Le Mans as its highlight, high-tech hybrid race cars are pitted against each other and in Formula E, all-electric single-seaters are. For Schaeffler, both racing series have become pioneering test beds for future technologies

“The commitments in the WEC and in Formula E have been helping us gain a better understanding of the environment and systems of electric mobility,” explains Prof. Peter Gutzmer, Schaeffler’s Chief Technology Officer. Be it in terms of systems knowledge, the development of new materials, recuperation (recovery of braking energy) or thermal management – these are important findings which

also advance the Schaeffler technology group aside from racing with respect to ideas, visions and technologies for networked mobility for tomorrow. Schaeffler has significantly increased the size of its development team for electric vehicle components and new mobility concepts within a short period of time and is working at full stretch on sustainable mobility solutions. Six examples ...



E-bike

On bicycle expressways, powerful pedelecs – with Schaeffler hardware and software on board – provide a particularly fast and eco-friendly means of transportation for shorter distances. Branded as SCHAEFFLER VELOSOLUTIONS, the company offers an extensive and innovative product range. See also: www.schaeffler-velosolutions.com

Electric car

Schaeffler’s electric axles (pictured) help make traffic noise in inner cities a thing of the past, moving forward with a wide product range from Herzogenaurach. In this context, Schaeffler has developed an innovative modular system for electric axles in various configurations and build levels.



Bio hybrid

The innovative and compact mobility solution for urban areas not only provides weather protection but, featuring four wheels including an electric pedelec drive, high driving stability and ample stowage space. In spring of 2016, Schaeffler unveiled this design and development concept that met with positive response around the globe.

E-board

In addition to its handy dimensions, this ideal means of transportation for short distances in urban areas boasts hydraulic brakes and a range of 25 kilometers. At CES in Las Vegas in January 2017, Schaeffler showcased this prototype. Integrated in the board is a battery that drives the rear axle via an electric motor. The e-board is controlled using a stick with an ergonomically shaped handle.

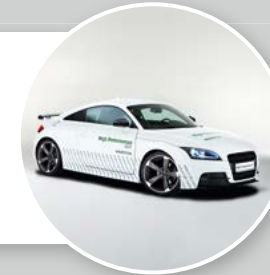


Robot taxi

Self-driving buses with integrated wheel hub motors (pictured) from Schaeffler could provide a means of demand-based zero-emissions short-range public transportation in the future. All the drive components except for the battery are completely installed in the wheel. They include the electric motor, power electronics, the brake and the cooling system. eWheelDrive makes all-new drive concepts possible.

Hybrid vehicle

Hybrid components will continue to make conventional IC engine based powertrains more efficient. Schaeffler offers solutions across the entire range of electrification potential – from the 48-volt hybrid to the plug-in hybrid for various mounting positions to all-electric axles that assist the IC engine or serve as the sole short-term source of propulsion.



Partners for 70 years



The first model marked the beginning of the collaboration between Porsche and Schaeffler in 1948. A flashback to an intensive and innovative partnership between a manufacturer and a supplier with a shared vision of automotive progress

The partnership between Schaeffler and Porsche that started as far back as in the days of the legendary 356 has now been in existence for seven decades. Thanks to cooperation in a spirit of mutual trust, many highlights of automotive progress have been brought to market during this period of time – see page at right. In addition to hydraulic bucket tappets, they include complex components such as electro-mechanical camshaft adjusters and roll stabilizers. A prototype of the latter was presented by Schaeffler in the CO₂cept-10% concept vehicle for the first time. In 2009, Schaeffler used this technology showcase based on a Porsche

Cayenne to demonstrate the optimization potential of modern automobiles yet to be tapped. The wide range of coordinated Schaeffler products used, caused fuel consumption and CO₂ emissions to drop by ten percent.

Know-how and ingenuity

Not only Porsche but all automobile manufacturers around the globe rely on innovative and active support by suppliers that decisively influence progress in automotive engineering thanks to the ingenuity of their development engineers and concentrated production know-how. ■



Porsche 356 from 1948 on

The **#cage-guided #INA needle bearing** is a fundamental invention the Schaeffler brothers achieve in the late 40s. Its advantages: reduced friction and torque stability. Many transmissions only become fit for high-speed freeway driving due to these bearings. Obviously, Porsche is among Schaeffler's customers.



Porsche 911 from 1963 on

In 1965, Schaeffler founds clutch manufacturer LuK and launches the first **#diaphragm spring clutch** on the European market. This innovation marks the beginning of a successful career. Today, one in three cars around the globe is equipped with a clutch from Schaeffler's LuK brand.



Porsche 917 1970

In 1970, Porsche evolves from a class to an overall winner at Le Mans. Operating in the twelve-cylinder engine of the 917 are **#bucket tappets** of Schaeffler's INA brand. For Schaeffler, the racing commitment serves as a test laboratory. Today, Schaeffler has a long history as a specialist in valve train components and systems.



Porsche 928 1977

Schaeffler engineers introduce hydraulics in the valve train. **#hydraulic #bucket tappets** like those Porsche puts on the road in the 928 launched in 1977 put an end to time-intensive garage maintenance by the bucket tappets independently adjusting valve lash.



Porsche 959 1986

In the 959 that achieves a speed of over 300 km/h Porsche puts the optimum of what is technically feasible on four driven wheels at the end of the 80s. Among the components on board is the **#hydraulic #chain tensioner**, a Schaeffler invention Porsche drivers enjoyed in the 911 as well.



Porsche 911 (Typ 996) 1996

With **#VarioCam Plus #variable #valve control** Porsche sets new benchmarks in terms of efficiency and performance. This technology supplied by Schaeffler makes it possible to perfectly adjust engine characteristics to the respective driving mode.



Porsche Cayenne S Hybrid 2010

This Cayenne is the first hybrid vehicle from Porsche. The hybrid module with an integrated electric motor sits between the IC engine and the transmission. A **#hybrid clutch** from LuK harmoniously moderates the interaction between the individual components.



Porsche 918 Spyder 2013

The Porsche 918 as a hybrid sports car marks the pinnacle of what is technically feasible. Detailed work and sophistication are featured in abundance here, the wheel bearings from Schaeffler being a case in point. In these bearings, **#ceramic balls** replace the usual steel rolling elements, saving 640 grams of weight.

Schaeffler is a global competence partner

Sustainable mobility is the primary development goal at Schaeffler around the globe. The product portfolio encompasses technologies for the engine, transmission and suspension as well as hybrid elements and electric powertrains, ranging from single components to complex systems. Energy efficiency takes center stage in all of them.

Mobility for *tomorrow*

For Schaeffler, innovation has been part of its corporate DNA ever since the company was founded. Lateral and interdisciplinary thinking is part of the program



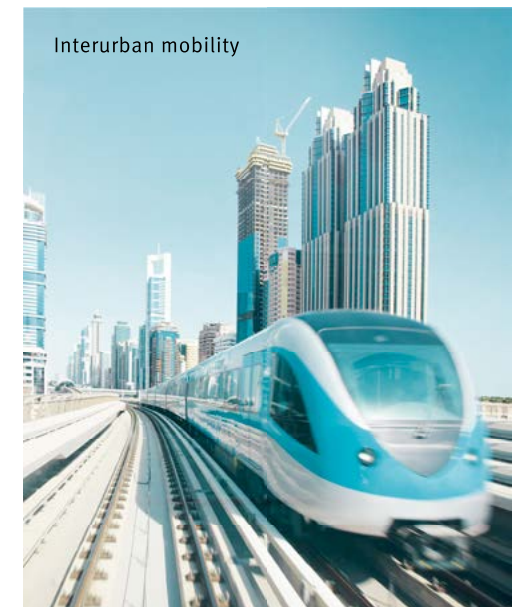
Energy chain



Eco-friendly powertrain technologies



Urban mobility



Interurban mobility

Schaeffler is known as an innovation leader delivering a wealth of technologies that make automobiles more fuel-efficient, environmentally friendly and safer. Additionally, the company offers products for trains, aircraft, wind turbines and many other industrial sectors. Schaeffler can be found wherever things are in motion. And motion means mobility as well. The challenges facing mobility of the future are immense. That's why Schaeffler is committed to its holistic "Mobility for tomorrow" strategy concept geared to finding sustainable solutions for the world of tomorrow. ■

"Progressive climate change, increasing urbanization and globalization, as well as digitalization will have a substantial impact on our lives and work. This particularly applies to the field of mobility"

Klaus Rosenfeld,
Chief Executive Officer Schaeffler

Schaeffler and Porsche

Four years in the WEC

3 drivers' titles

4 continents

3 manufacturers' titles

34 races

17 wins

7 consecutive wins

13 fastest race laps

20 pole positions

11 consecutive pole positions

10 nations

1,198 points






10 drivers

7 one-two wins







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