

13–15 JUNE 2019

# MISSION **H24**

STAGE 5  
**2019 24 HOURS OF LE MANS**



AT 14:42 ON SATURDAY 15 JUNE, A HYDROGEN-FUELLED RACING CAR WILL TAKE TO THE TRACK AS PART OF THE ICONIC 24 HOURS OF LE MANS STARTING CEREMONY.

## Introduction

From drawing board to track, dream to reality, here and now, today for tomorrow, ladies and gentlemen, we give you MissionH24. Watch as we push back the frontiers of technology, taking a laboratory prototype from the design stage to the world stage.

MissionH24, a project led by the ACO and GreenGT, draws on the skills and knowledge of the entire spectrum of motoring, from the racing track to everyday road. Our mission is to use endurance racing to showcase the performance and reliability of hydrogen, to demonstrate new ways of powering vehicles, and play a part in saving the environment.

Follow our progress as we pave the way to 2024 and the introduction of a class for hydrogen prototypes at the 24 Hours of Le Mans.

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## Stage 5:

**2019 LE MANS 24 HOURS, 15 JUNE, 14:42**

**The LMPH2G electric/hydrogen prototype to open the proceedings at the 2019 24 Hours of Le Mans**

**At 14:42 on Saturday 15 June, the LMPH2G racing prototype, the outcome of the MissionH24 partnership uniting the ACO and GreenGT, and supported by Total, will take part in the traditional starting procedure for the 2019 24 Hours of Le Mans.**

Before the 62 cars entered in the 87th running of the world's greatest endurance race are unleashed, the hydrogen-powered racing prototype will complete a demonstration lap of the full 13.626-kilometre circuit.

Scheduled just a few minutes before the race start (15:00), this will be a significant milestone in the MissionH24 project spearheaded by the ACO and GreenGT, joined by Total to promote hydrogen power in motor racing. Their determination to achieve zero-carbon mobility will be witnessed by a worldwide audience gathered to watch the biggest endurance race of the year. MissionH24's ultimate goal is to introduce a special hydrogen prototype class at the 2024 Le Mans 24 Hours.

At 14:42 on Saturday 15 June, be among the millions of spectators to watch zero-carbon mobility take off in earnest.



## What is MissionH24?

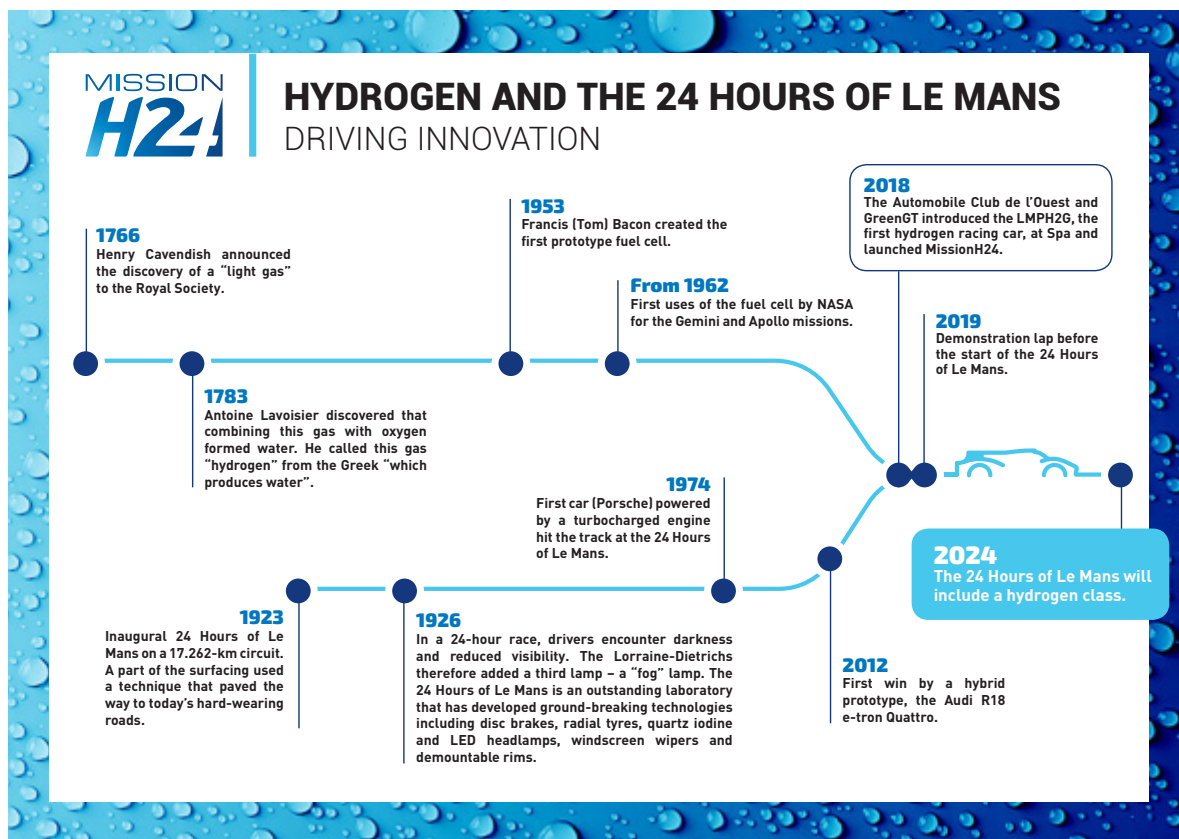
Mission H24 aims to introduce hydrogen-powered racing cars to the 24 Hours of Le Mans in 2024, when a special hydrogen class will be created for a zero-emission race. An array of technologies have been launched and tested at Le Mans over the years. This latest challenge seeks to speed up research and development around this new fuel type, with the ultimate aim of taking it from track to the road to achieve zero-carbon mobility.

The ACO has always been driven by its love of racing but the organiser of the 24 Hours of Le Mans never loses sight of its responsibilities. Hydrogen is a public-interest choice: it is a global challenge that addresses some of the major issues of our time, such as urban air pollution and the need to find new sources of fuel to replace conventional hydrocarbons.

Mission H24 is not unlike the Apollo programme launched in the United States in 1961 and which, after a series of test flights, achieved its goal of putting men on the moon in 1969. Similarly, there will be several milestones to reach before hydrogen-powered cars can race at the 24 Hours of Le Mans in 2024. Mission H24 will be officially launched at Spa Francorchamps, the setting for the fifth round of the 2018 ELMS (European Le Mans Series) on 22 September.

Introducing hydrogen to the race track is a real challenge – but a tangible and realistic one as the technologies already exist. Mission H24 will help develop less expensive, more effective solutions to sustainable power sources. This project is the first, determined step towards sustainable, responsible zero-carbon mobility. Hydrogen unlocks multi-mobility potential as the technology suits every kind of journey, long or short, by car, bus or truck, or even by train, boat or plane.

After successfully enabling technologies such as front-wheel drive, disc brakes, direct injection, the gas turbine engine, the rotary engine, the turbo, and diesel and hybrid power, the ACO is now committed to hydrogen-powered mobility with Le Mans 2024 its target. We would be delighted if you would join us on this journey.





## Who is involved?



### THE ACO PARTNERED BY GREEN GT

In 1923, the ACO founded the 24 Hours of Le Mans, not only for the joy of racing but also – and above all – to test and validate the reliability and performance of the innovations dreamt up by car manufacturers. Le Mans is often described as the toughest race in the world and has always promoted the notion of 'Racing to the Future'.

For **Pierre Fillon**, President of the Automobile Club de l'Ouest, "Mission H24 embodies our commitment and our beliefs. Last June at the 86th Le Mans 24 Hours, we announced our intention to create a hydrogen class for Le Mans 2024. Things are now starting to happen. We believe in hydrogen, just like we believed in hybrid technology and the introduction of a limited energy allocation. Today, hybrid cars are driven on public roads across the world. Research is an ongoing concern for us as the organisers of the 24 Hours, and encompasses the fields of safety, performance, lower fuel consumption and environmental protection. At the ACO, we have always worked alongside manufacturers and other stakeholders in the automotive sector, and we see Mission H24 as a genuine commitment to future mobility. With assistance from Green GT, we will rise to this new challenge and will keep you regularly updated, at every step of the way to our ultimate goal in 2024."



## Who is involved?



GreenGT is a high-tech company devoted to researching, developing and implementing hydrogen-powered electric motors using fuel cells. Green GT develops innovative, zero-carbon powertrains. Thanks to these safe, effective solutions, the energy transition in transport is under way.

**Christophe Ricard**, president of GreenGT: *"MissionH24 is where endurance racing meets sustainability and technology meets emotion. My heartfelt thanks go to the ACO, represented by Pierre Fillon, for providing us with an incomparable environment in which to experiment."*

**Jean-Michel Bouresche**, Director of GreenGT Technologies: *"We had no hesitation in joining the ACO on Mission H24. We have been convinced about the potential of hydrogen for several years now and have developed sound experience and recognised expertise in the field. Speeding up the research process via motorsport is a challenge that we are enthusiastically – but realistically – ready to accept."*



## A major partnership



Total will be providing the hydrogen fuelling system for MissionH24 – a key contribution to the project. The specially designed compact portable filling station fits in a 6 x 2.5-metre shipping container that can be transported to circuits around the world, ready to fuel the LMPH2G's future endeavours on the racing track. The mini filling station houses a hydrogen tank, a multi-stage compressor, a cooling system and a distributor/connector to dispense the fuel.

The system currently feeds hydrogen at 350 bars. The intention is to reach 700 bars, in line with the development of the car.

The filling station was specifically designed to meet the constraints of endurance racing in terms of rapidity, with safety the number one priority.

Hydrogen is a high-potential energy source, producing storable, zero-emission fuel. Total is a member of the H2 - Hydrogen Council and, along with 12 other global leaders in energy, transport and manufacturing, strives to promote hydrogen's key role in energy transition. Total is also involved in H2 Mobility in Germany, a joint venture launched in 2015 with Air Liquide, Daimler, Linde, OMV and Shell, with the aim of building a nationwide network of 400 hydrogen filling stations.

A major energy company, Total produces and markets fuels, natural gas and low-carbon electricity. Our 100,000 employees work to make energy better, safer, more affordable, cleaner and more widely available. With an operation spanning 130 countries, we aim to lead the way in responsible energy.

**Philippe Montantème**, Senior Vice President – Strategy Marketing Research at Total Marketing Services SA: *Total established a partnership with the Automobile Club de l'Ouest in 2018 and is official fuel supplier of the FIA World Endurance Championship, including the 24 Hours of Le Mans. Our research and development team has been working closely with manufacturers for over thirty years, ensuring our products evolve in line with automotive technology and racing regulations. Mission H24 gives us the opportunity to put together a customised package for the ACO/GreenGT joint venture – a hydrogen fuelling system that is both energy efficient and raceworthy.*

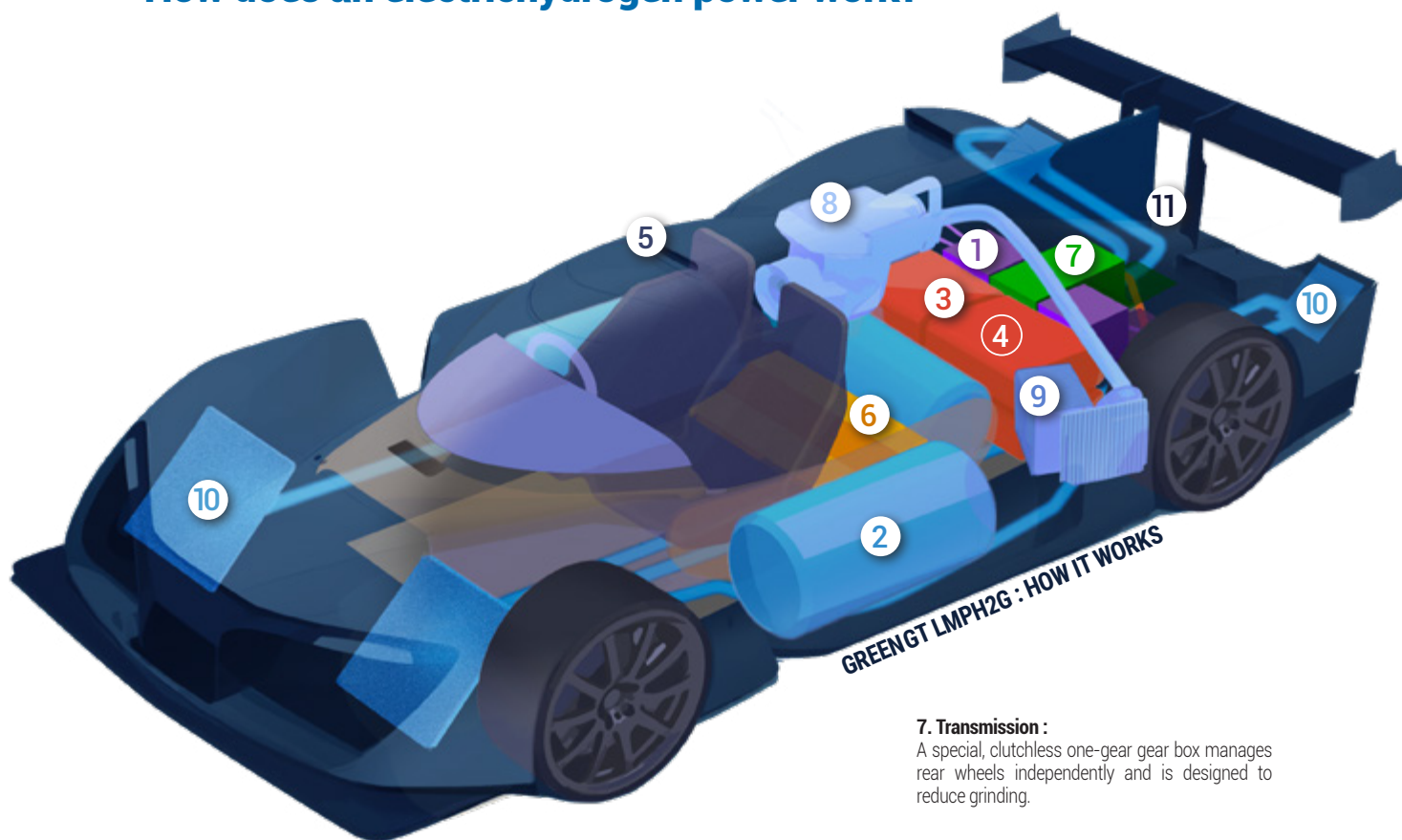


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## How does an electrified hydrogen power work?



### 1. Electric motors:

Four electric motors on the rear wheels (two on each) provide propulsion.

### 2. Three hydrogen reservoirs:

The dihydrogen ( $H_2$ ) is stored in three pressurized (700 bars) carbon filament tanks used to fuel the cell. The first two are placed either side of the cockpit and the third just behind the driver.

### 3. Hydrogen fuel-cell:

Comprises four stacks, at the core of which molecules of dihydrogen ( $H_2$ , stored in the tanks) and oxygen atoms combine to form water molecules ( $H_2O$ ). This reaction produces heat, and electricity, which powers the car's electric motor.

### 4. The stack

A layered pile of 230 cells, bipolar plates and hydrogen porous membranes.

### 5. Air Intake:

The ambient air used to produce the reaction within the stacks enters through this vent. It is filtered, propelled towards the compressor, then the humidifier, before entering the stacks.

### 6. Buffer batteries:

Excess electricity produced by the hydrogen fuel-cell and by the KERS system (when braking) feeds into high-performance cells. The driver can therefore double the car's acceleration potential (250–480 kw, the equivalent of 653 hp).

### 7. Transmission :

A special, clutchless one-gear gear box manages rear wheels independently and is designed to reduce grinding.

### 8. Compressor:

Compresses and accelerates the air that enters via the vent (up to 300g per second). It operates at up to 100000 revolutions per minute. The modulation of the air flow injected in the stacks alters the reaction and therefore determines the amount of electric power produced.

### 9. Humidifier:

Humidified air improves the interaction between oxygen atoms and dihydrogen molecules. The humidifier ensures the level of humidity of the air injected in the stacks remains constant.

### 10. Radiators and cooling system

### 11. Exhaust:

The only emission produced by the GreenGT LMPH2G is water ( $H_2O$ ). Steam escapes through four vents (one per stack) to the rear of the car, in the middle of the aerodynamic diffuser.



## Hydrogen is safe

There are many preconceptions about hydrogen, one of which is that it is dangerous. Discovered by Henry Cavendish in 1776, hydrogen and its properties are now well known and today the risks have been pinpointed and contained by safety measures and standards. Fire prevention professionals now consider hydrogen safer than any other fuel used in the open air. It goes without saying that storage tanks meet the strictest requirements in terms of resistance.

At Spa, the refuelling pitstop will put an end to any fears about the safety of storage or refuelling. The operation will be completed by an operator wearing normal clothes. With no need for overalls or helmet, they will simply have to fit the valve and job done! Or almost. Hydrogen (gas) is contained in sealed tanks at 700-bar pressure. The tank's seals and contents are systematically checked before the hydrogen is injected.

**Yannick Dalmas**, driver of the car at Spa: *"it's a privilege to be part of such an event, to take the wheel of a hydrogen-powered car. I can assure you I was not at all worried about driving a car with hydrogen on board. Everything is perfectly under control with numerous safety measures and checks. The stealthy silence of the prototype as it leaves the pit lane is remarkable. It feels different to drive and I needed to have several procedures explained."*

## Hydrogen is simple

Some people think that the hydrogen engine is a labyrinthine set-up but the hydrogen racing car is a simple hydrogen/hybrid vehicle. There are several ways of producing hydrogen and the ACO has naturally opted for 'green' hydrogen, i.e. that produced using a carbon-free process.

- 'Green' hydrogen can come from the fermenting of bioresources such as biomass, waste or methane.
- 'Green' hydrogen can be obtained using water electrolysis where the electricity is generated by renewable.

**Sources** (water electrolysis applies an electrical current to split water into oxygen and hydrogen).

## Hydrogen is promising

The European Commission's Director-General for Mobility and Transport, Henrik Hololei, was present on Saturday 22 September at Spa-Francorchamps to take part in the world launch of MissionH24 by the ACO in collaboration with GreenGT and the demonstration of a hydrogen racing car (the GreenGT LMPH2G), including refueling in pit lane. The Automobile Club de l'Ouest, convinced of the relevance of hydrogen, has cited 2024 as the year hydrogen prototypes will be allowed to participate in the 24 Hours of Le Mans.

"We've just served as witnesses to a huge debut as a new chapter in history was created today by MissionH24," declared **Henrik Hololei**, the European Commission's Director-General for Mobility and Transport. "This event is particularly important. I couldn't wait to see this hydrogen racing car. We need to make available zero-emission modes of transportation for a sustainable future and to develop new solutions. These are real challenges. I would like to congratulate and encourage ambitious people and projects like MissionH24."

There are no consumption or performance targets for Mission H24's demonstration at Spa, ten months ago. The car on the track (LMPH2G) is a prototype (LMP3) that is still at the experimental phase. The development work has yet to begin. So seeing the car complete its first few miles last January, and watching it set the pace as the leading car and clocking up top speeds of 300 kph is more than just promising.



### MODULE ÉNERGÉTIQUE ÉLECTRIQUE-HYDROGÈNE GREENGT : 4 MOTEURS ÉLECTRIQUES DE COURSE + 1 PILE À COMBUSTIBLE H2 GREENGT ELECTRIC-HYDROGEN ENERGY MODULE: 4 ELECTRIC RACING ENGINES + 1 H2 FUEL CELL

#### MOTEUR ENGINE

- 4 moteurs électriques de course 4 electric racing engines
- Puissance max. : 480 kW à 13000 tr/min (653 ch)  
Maximum power: 480 kW @ 13000 rpm (653 bhp)

#### CHÂSSIS CHASSIS

- Châssis LMP en carbone et structure d'acier LMP carbon chassis plus steel structure
- Freins en carbone Carbon brakes
- Suspensions av. et ar. à triangles et poussoirs  
Front and rear wishbone suspension and push rod

#### TRANSMISSION TRANSMISSION

- Transmission directe aux roues arrière (ratio 1:6,3)  
Direct drive to rear wheels (ratio: 1:6.3)
- Système électronique de gestion variable du couple  
GreenGT GreenGT variable torque vectoring system

#### PRODUCTION D'ÉNERGIE ENERGY PRODUCTION

- pile à combustible à membrane électrolyte polymère à 250 kW constants  
Fuel cell with polymer electrolyte membrane of 250 constant kW
- 4 stacks 4 stacks

#### SYSTÈME DE RÉCUPÉRATION D'ÉNERGIE AU FREINAGE ENERGY RECOVERY SYSTEM UNDER BRAKING

- batterie de 750 V en nominal Battery 750 V nominal
- capacité de 2,4 kWh Capacity: 2.4 kWh
- 250 kW délivrés pendant 20 s 250 kW transmitted for 20 s

#### STOCKAGE DE L'HYDROGÈNE HYDROGEN STORAGE

- capacité de réservoir : 8,6 kg Fuel tank capacity: 8.6 kg
- Pression de stockage : 700 bars Storage pressure: 700 bars

#### POIDS (VERSION DE ROUTE) WEIGHT (STREET VERSION)

- 1420 kg en ordre de marche 1420 kg in running order
- répartition des masses : av. 39,8% / ar. 60,2%  
weight distribution: front 39.8% / rear 60.2%
- Variation du poids au ravitaillement : + 8,6 kg  
weight variation during refuelling: + 8.6 kg

#### PERFORMANCES PERFORMANCES

- vitesse maximale : 300 km/h max speed 300 km/h
- 0 à 100 km/h : 3,4 s 0 to 100 km/h: 3.4 seconds
- 0 à 400 m : 11 s 0 to 400 m: 11 seconds

## LMPH2G SPECIFICATIONS

### Châssis :

- Carbon LMP Chassis with steel frame
- double wishbone pushrod suspension
- carbon brakes

### Engine:

- GreenGT electric-hydrogen powertrain (4-stack fuel cell with polymer electrolyte membrane) producing a constant 250kW
- 4 electric motors (2 per rear wheel)
- Maximum output of 480 kW at 13000 revs (653 hp)
- 2.4kWh KERS delivering 250 kW for 20 seconds

### Transmission :

- Direct drive to rear wheels (ratio: 1:6.3)
- No gear box, no clutch, no mechanical differential
- Electronic torque management system

### Hydrogen Storage:

- Fuel tank capacity: 8.6kg of hydrogen
- Storage pressure: 700 bars

### Kinetic energy recovery system (KERS):

- 750V battery, nominal voltage
- Capacity: 2.4 kWh

### Measurements:

- Length: 4 710 mm
- Height: 1 070 mm
- Width: 1 970 mm
- Wheelbase: 2 970 mm
- Front overhang: 1 000 mm
- Rear overhang: 740 mm
- Weight: 1 420 kg in working order (front: 39,8 % - rear: 60,2 %)
- Weight variation at refuel: 8.6kg

### Wheels

- Front 30/68-18 Michelin Pilot Sport GT (hub 12X18)
- Rear 31/71-18 Michelin Pilot Sport GT (hub 13X18)

### Performances :

- Maximum speed: + 300 kph
- 0–100 kph: 3.4 seconds
- 400 metres, standing start: 11 seconds
- Range: equivalent to other racing cars with comparable performance
- Refuelling time: 3 minutes.

### Emissions into the atmosphere:

- Water vapour only

## Stage 1:

### SPA-FRANCORCHAMPS, 22 SEPTEMBER 2018

The LMPH2G hydrogen-powered prototype made its world début on the famous Belgian track of Spa-Francorchamps during the fifth round of the ELMS on 22 September 2018. Project MissionH24, a joint venture conducted by the ACO and GreenGT, was proud to show off the car in its experimental phase. The aim of the demonstration, witnessed by European Commission Director-General for Mobility and Transport Henrik Hololei, was threefold: to show that hydrogen is safe, simple and promising. At Spa, the refuelling operator had no extra protective clothing other than the mandatory firesuit and was keenly observed by a group of experts.

Four-time winner of the 24 Hours of Le Mans, **Yannick Dalmas** was at the wheel. Yannick Dalmas, driver of the leading car: *"it's a privilege to be part of such an event, to take the wheel of a hydrogen-powered car. The stealthy silence of the prototype as it leaves the pit lane is remarkable. It feels different to drive and I needed to have several procedures explained. For a machine that is yet to enter the development stage, the whole package is really promising. I had the utmost confidence in the car, and was impressed that its only emission is water vapour."*

## Stage 2:

### PARIS, MONDIAL TECH, 5 OCTOBER 2018

The prototype was displayed at Mondial Tech, the B to B event at the Paris Motor Show, complete with a bottle of water, the sum total of the car's emissions during the demonstration at Spa-Francorchamps. *"We believe that endurance racing can contribute to sustainable development. That's why we are exploring hydrogen power, which has enormous potential in terms of road, rail, maritime and air transport, all with zero emissions. The prototype has yet to be developed for racing, but we intend to introduce a category for hydrogen-powered cars for Le Mans 2024"*, **Pierre Fillon**, President of the Automobile Club de l'Ouest, comments.

The LMPH2G attracted many admirers.



## Stage 3:

### PARIS, 4 FEBRUARY 2019

The Automobile Club de l'Ouest and GreenGT announced that they had founded H24Racing team, as part of MissionH24. The team will be running a hydrogen-electric racing car in endurance series. One of the crucial stages of the MissionH24 project will be to test hydrogen powered racing in the discipline's feeder series before launching a hydrogen class at the 2024 24 Hours of Le Mans.

As demonstrated time and again by the ACO, endurance racing is one of the best testing grounds a manufacturer could dream of, especially where sustainable development is concerned.

**Pierre Fillon**, ACO President: *"With H24Racing, the joint venture between the ACO and GreenGt takes on a sporting aspect. This renders tangible our commitment to ensuring that technical progress like hydrogen reaches the general public."*

## Stage 4:

### LE MANS, BUGATTI TRACK, ASSISES DE L'AUTOMOBILE, 28 MARCH 2019

**Bertrand Piccard**, a keynote speaker at the automotive conference organised by Ouest-France and the ACO emphasised the importance of endurance and the 24 Hours of Le Mans in developing future mobility. The initiator, chairman and co-pilot of Solar Impulse, the first successful round-the-world solar powered flight, took a seat in the LMPH2G for a lap of the Bugatti circuit.

*"The future of motoring hinges on the management of the ecological transition", he said. "We must replace something that pollutes with something clean. It gives me immense pleasure to take to this track in a hydrogen prototype. I even had the opportunity to drink the water it produces. The 24 Hours of Le Mans will soon be open to hydrogen cars, which is fantastic. As such, you will be doing a good deed for humanity, because this race has huge influence."*



Keep track of the event on social media:



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