



# Hydrogen Mobility Michelin's vision



June 25th, 2015  
CREM - Martigny (VS)



# Michelin committed to Mobility Since 125 Years





# Many Customers

**Tire business:  
Net sales 2014: 20 Md€**



**Passenger  
car & Light truck**



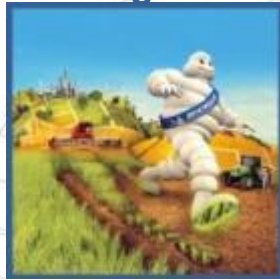
**Truck**



**Earthmover**



**Motorsports**



**Agriculture**



**Aircraft**



**Motorcycle**



**Bicycle**

# Hydrogen Helps to answer European Expectations: Energy Security and Air Quality

## Hydrogen helps to solve the Urban Air Pollution problem

- In line with European Air Quality Standards Regulations<sup>(1)</sup>
- Reducing health risks<sup>(2)</sup> of millions of EU Citizens

## Local production of hydrogen reduces fossil fuel dependency

- Through Renewable energies, Nuclear and Biogas

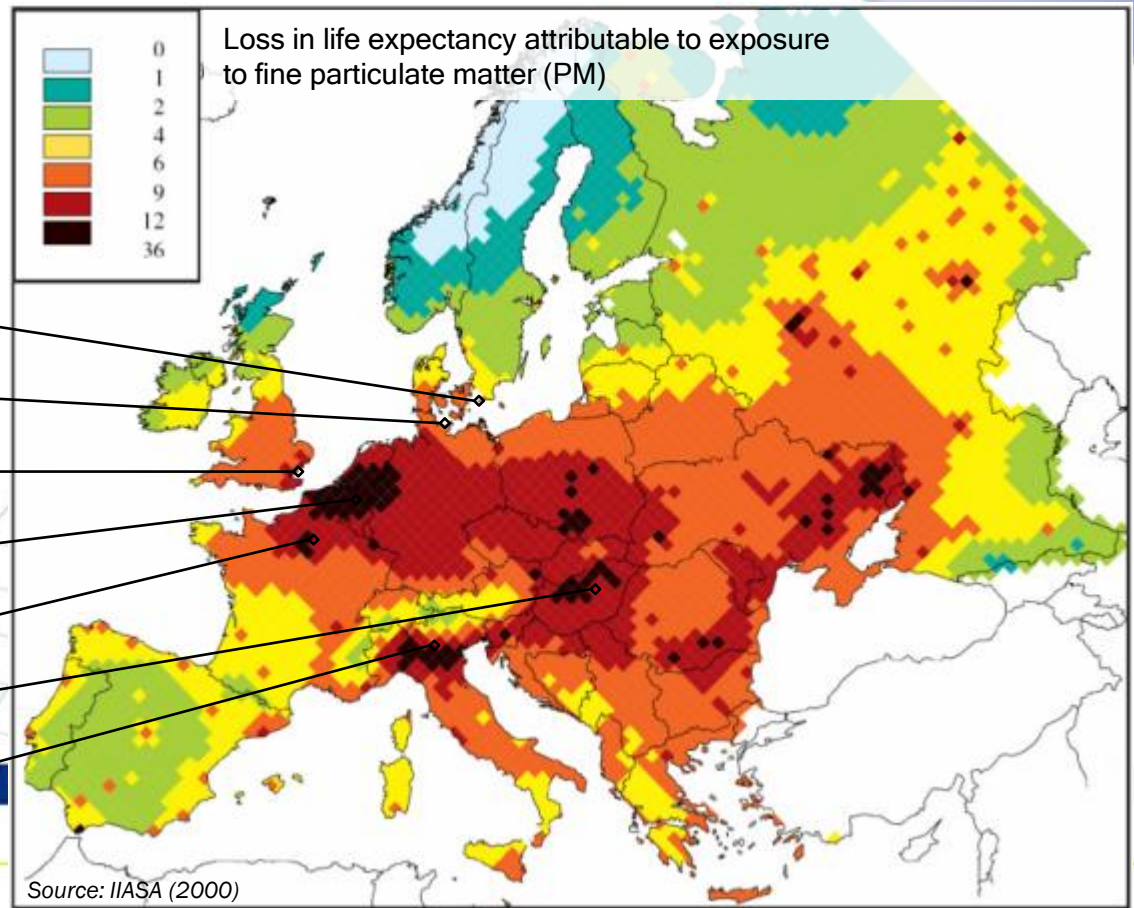


(1) <http://ec.europa.eu/environment/air/quality/standards.htm>, Clean Air for Europe (CAFE), European Commission Transport White Paper, TEN-T, CIVITAS

(2) Cancer, asthma, emphysema, heart disease, CVA (stroke), and other potentially lethal conditions...  
IARC: Diesel Engine Exhaust is Carcinogenic (June 12, 2012)



# Major cities cannot ignore societal need for a better Air Quality



Copenhagen  
Hamburg  
London  
Brussel  
Paris  
Munich  
Milano



And particulate Matter (PM 10 & PM 2.5) are not the only pollutants:

- Ozone
- NOx
- SOx
- Polycyclic aromatic hydrocarbon
- CO



# Due to citizen pressure, cities are limiting access for Noisy & Polluting vehicles



A real Headache for delivery and other services companies



Several types of technologies will definitely co-exist in the future

For Delivery Vehicles, duty cycle needs will drive choice of technologies

Daily Energy Needs

400 kWh

200 kWh

100 kWh

20 kWh

Batteries

Hydrogen  
Range Extender

Hydrogen  
Full Power

Diesel

H2 range extender solution kill the limitations of pure battery vehicle:

- Double the range
- «instantaneous» refilling time
- Sweeps the «winter effect»



**Movements are going  
fast and serious now in hydrogen  
mobility!**

## **Announcements – Key Facts 2014**

### **Japon**

Toyota sells since december 2014 the 1st Fuel cell vehicle :Toyota Mirai. Price 36'500 € net (including government subsidies of 14'500 €) ; estimated cost for Toyota: 150'000 €

Toyota discloses to other companies its family of patents concerning fuel cell technology.

Government will make simpler regulations for fuel cell vehicles

Honda, 1st sales in Q1 2016.

### **Korea**

Hyundai will produce 100 vehicles in 2015: renting 500\$/moonth in California.

### **USA**

48 stations H2 in California by end 2016 and 12 in Nord-east, built by french company Air Liquide

### **China**

Partnership VW-SAIC for development of Plug-in Hybrid and fuel cell vehicles





# Movements are going fast and serious now in hydrogen mobility!

## Announcements – Key Facts 2014

### Allemagne

Volkswagen discloses in L.A. motorshow 3 models of fuel cell vehicles.  
VW has bought canadian Ballard's IP rights on Fuel Cell technologies  
Daimler (cooperation with Ford & Nissan) announced a market vehicle for 2017.



### France

H2 Mobilité France (Michelin is stakeholder) discloses its study results:

First step in 2015 with fleet vehicles,  
Wider deployment of H2 refilling stations up to 2030 .

Law on «transition énergétique» includes provisions for promoting fuel cells and H2 infrastructure.

**Michelin** has taken a significant share in the french start-up **SymbioFCell** for accelerating the industrialization of fuel cells. It will leverage both companies movement to the market.



# Why Fuel Cell in Michelin?

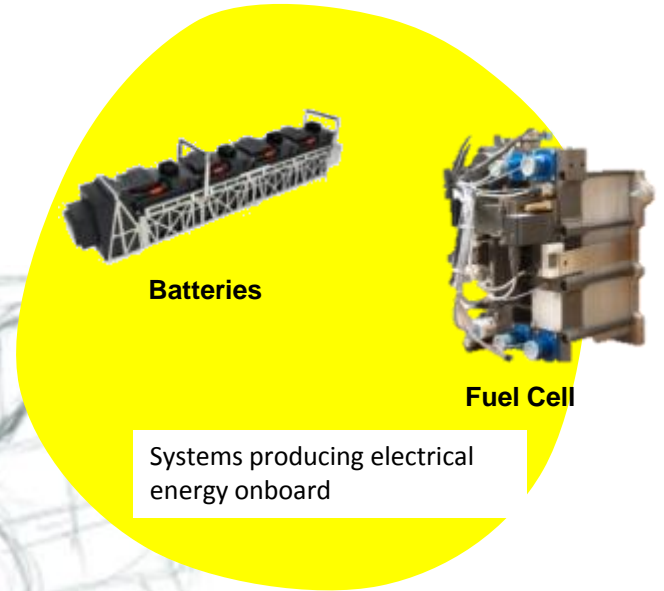
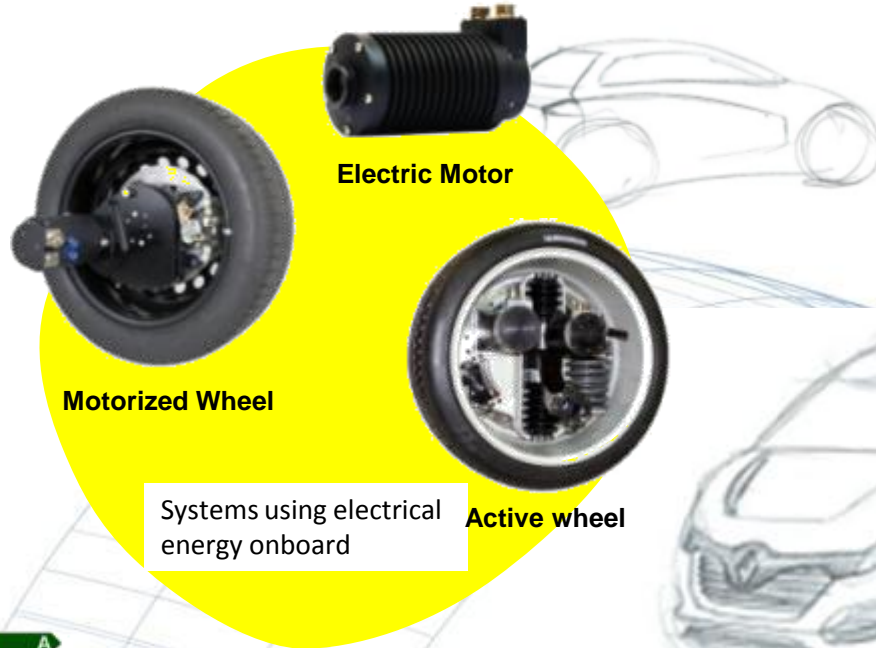
The clear willingness to address  
Innovation out of the tire

## An innovation research center dedicated to clean technologies for sustainable transport

- + Created in 1996 in Fribourg, Switzerland, to meet the challenges of sustainable mobility
- + 66 people (50% with a strong engineer background)
- + R&D in activities « out of the scope » of tires
- + Strong involvement in its ecosystem: AFHYPAC & AVERE member, Competitive Clusters



# Zero emission technologies were right from the beginning a « no-brainer »



Energy consumption



Energy management



# A broad portfolio of sub-systems for clean transport has been developed

## In-Wheel Motor Technologies

Active Wheel, Motorized Wheel, Electric Motor



## Fuel Cell

Fuel Cell, Sensors, H<sub>2</sub> storage system



Integration



Demo Vehicles

## Composite materials

Lunar Wheel, Tweel, Fibers



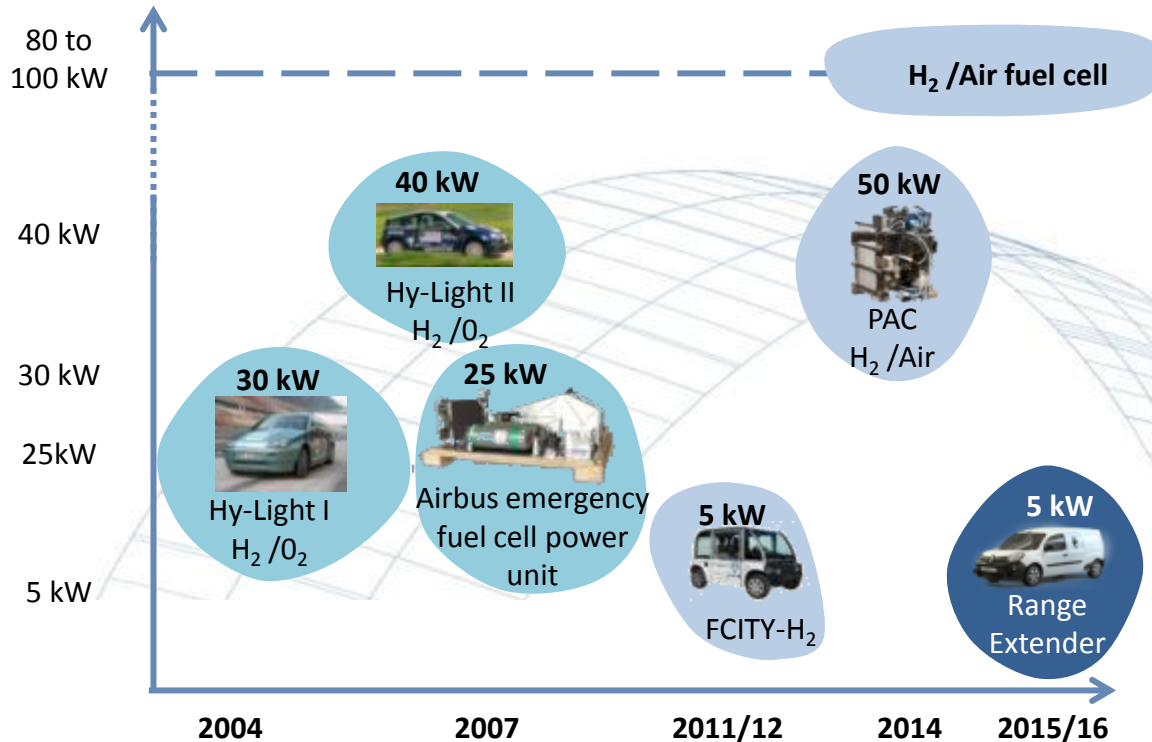
## Electronics

Software, Power electronics



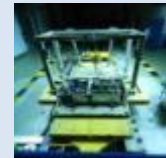


## Real know-how applied to system integration



## Stack Design and Validation:

- Performance Test, Start & Stop Test, Lifetime / Degradation test
  - 24/24 test benches and real road cycle tests
- Operation at low temperature & freeze start (-25°)
  - Compliant with automotive specification, 50% max power in less than 30s
- Electromagnetic compatibility, emission measurement, vibration and shock test



# Which strategy for deployment of fuel cell vehicles? How to manage the infrastructure debate?

- Answering with Fuel Cell the limitations of battery vehicles → Range extender
- Fleet vehicles as first customers
- Refilling station for one or several fleets → cluster



# H2 Range Extender kills the limitations of pure battery vehicle

Starting from an existing electric vehicle, the H2 range extender (prolongateur d'autonomie)

- Doubles the range of the vehicle
- Some minutes only for refilling H2 tank
- No winter effect!

No Winter Effect with our kit<sub>(2)</sub>



20 °C

Kangoo ZE

Kangoo ZE + Kit



5 °C

Kangoo ZE

Kangoo ZE + Kit



-5 °C

Kangoo ZE

Kangoo ZE + Kit

<50 km

60 km

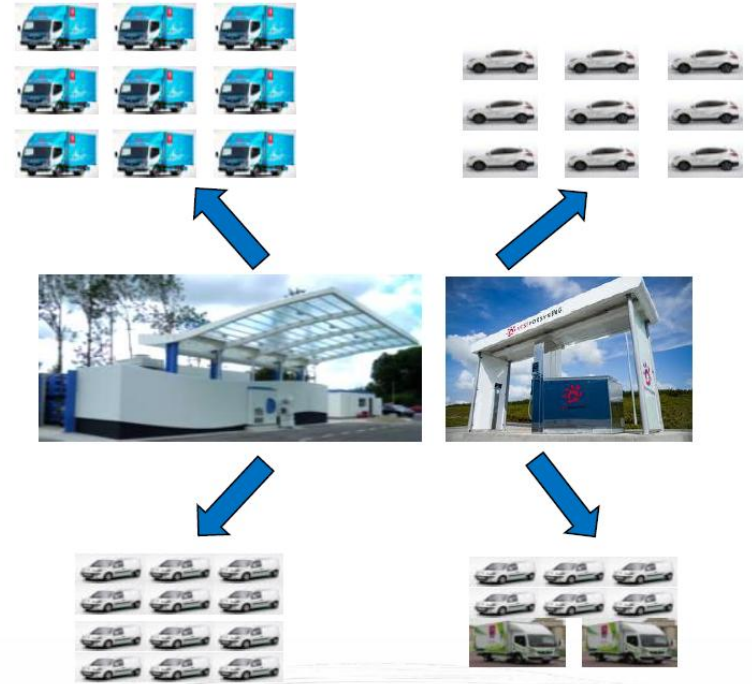
80 km

160 km

# Captive fleets are a key enabler For chicken-egg dilemma!

Fleet vehicles have predictable driving cycles  
And visit back for night parking

One cluster gathers several fleets.  
One H2 refilling station for one cluster  
→ investment amortization easier





# Conclusions



- **Fuel cell vehicles is no more a dream! Technology is mature.**
- **Original business model for a coming ramp-up including range extenders, fleet customers and dedicated infrastructure**



A vibrant, futuristic scene set in a high-tech car repair shop. In the center, a sleek, white, aerodynamic car is being worked on by a large, white robotic arm. To the right, the iconic Michelin Man character, Bibi, stands on a platform, wearing a blue sash with the word "MICHELIN" on it. He is pointing towards the car. In the foreground, a man in a light blue lab coat and safety glasses is holding a flashlight, looking at the car. To his left, another man in a lab coat stands with a question mark above his head, looking towards a robotic arm that is holding a tire. In the background, two other people are standing on platforms, one holding a tire. The shop is filled with various mechanical parts, tires, and futuristic equipment, all under bright, cool-toned lighting. The overall atmosphere is one of advanced technology and customer service.

**THANK YOU FOR YOUR ATTENTION**