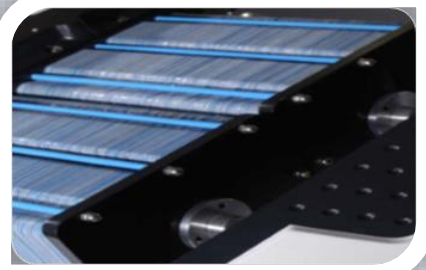
Hydrogen @UL: 5 steps for a global vision of the hydrogen sector



Green hydrogen production

- PEM water electrolysis
- New routes : photocatalysis, bio-production

Fuel cells, compression and storage

Micro-grids

- Multi-energy, multi carrier
- (includes embarked microgrids)

Societal issues

- Economy
- End user perspectives
- Education to H2

Education and training in higher education

- Technician
- Master

Materials → Components → Systems → Societal impact

Project Hy2Car : an Hybridized Hydrogen car

A new concept for an urban personal vehicle : clean (zero emission), energy efficient, low cost

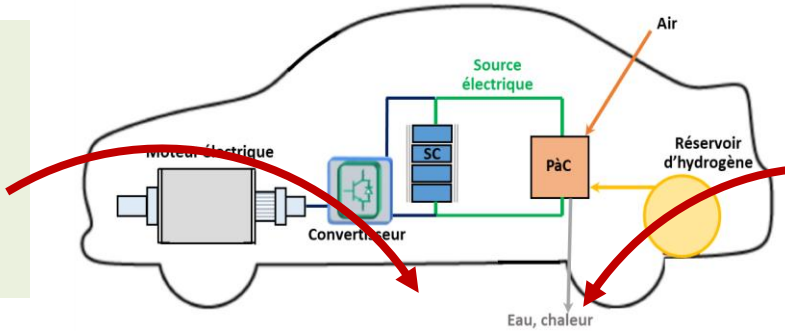
Overall concept

- **Clean** : powered by a PEM fuel cell hybridized (PEMFC) with supercapacitors(SC)
- **Energy efficient** : propulsion system fitted to the usage
- **Usage** : second familial vehicle
- **@ a competitive cost**

Technical concepts

- Based on an electric car : batteries are replaced by supercapacitors to hybridize the fuel cell in a direct way
- A single electronic converter is used → (volume and mass reduction, breakdown limitation…)
- Fuels cell protection and mitigation of the aging of the FC are achieved

SC = POWER
Transitories management and permits a reduction of :
- FC size
- H_2 comsumption

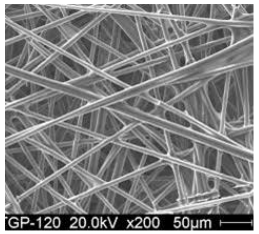


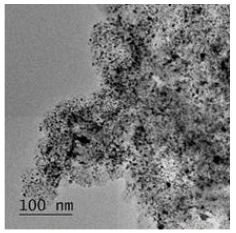
PEMFC = ENERGY
Autonomy
Fueling in a few minuts
Zero pollution : only water !

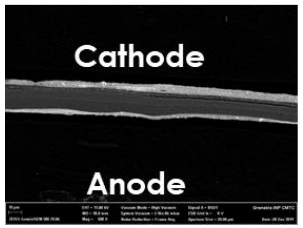
Research on the technology core

❑ **To enhance performances and durability : analysis of physical phenomena in the components of PEM Fuel Cells**

Material sciences

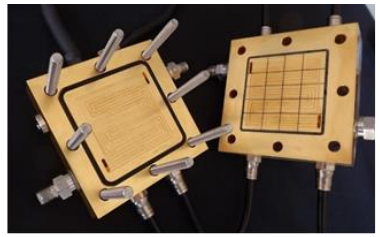


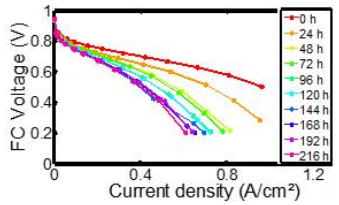


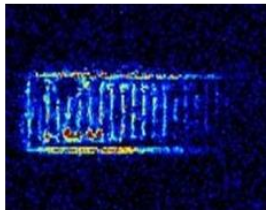


Membranes, catalysts, bipolar plates…

Engineering







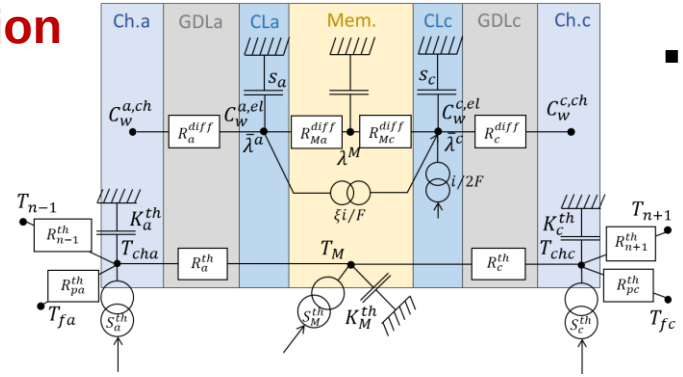
Fuels cells architecture, fluidic, thermal management

Electrical engineering

Systems for applications…

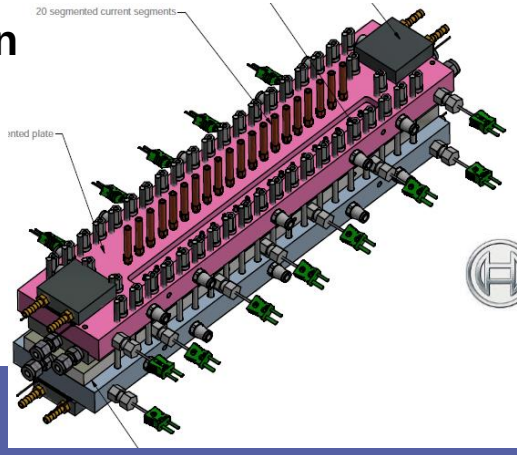
❑ **Automotive application**

- **Model development**



- **Experimental validation**

Segmented cell
→ Local in-situ analyses



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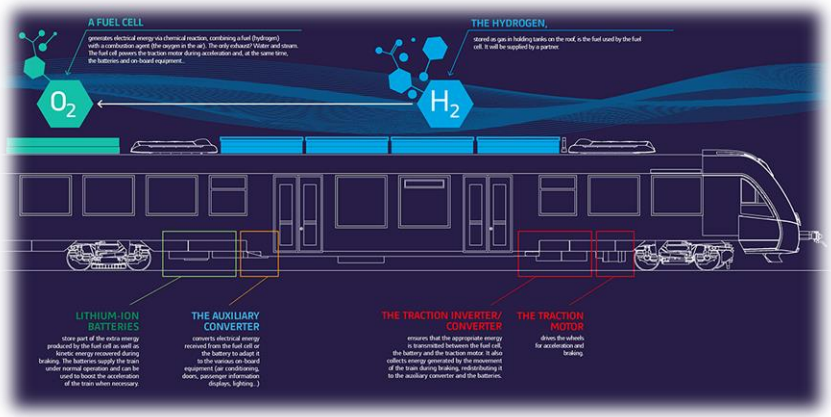
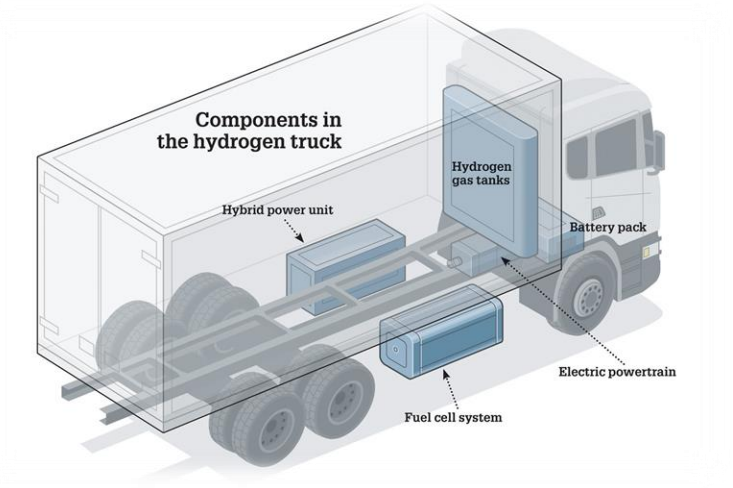
Heavy mobility, using hydrogen as an energy source

Challenges for energy management



Challenges

- ▼ costs
- ▲ reliability
- ▲ lifespan



Research on smart energy management of fuel cell systems using power electronics

- **High efficient, fault tolerant power architecture**
- **Hybridization with the storage system (batteries) : centralized vs distributed**
- **Architecture by power modules to ease the power ramp-up**
- **Multi stacks architecture for fuel cell to improve energy availability, efficiency and overall durability**
- **Optimization of the lifespan by smart management ; development of diagnostics /prognostics tools**

Some further recommendations

- Forster ideation and emergence of new concepts based on prospective (oriented to future usage),
- Avoid too “techo-push” approaches, an prefer a need seekers one
- Take into account socio-technics concerns to ensure acceptance and development, ensure this points by developing living labs, involving researchers, users, industrials, deciders.
- Develop systemic analysis and modelling of hydrogen eco-systems, especially for mobility concerns : H2 production, compression, distribution, socio-économics actors, end-users
- Encourage and fund an active R&D&I on core technologies (fuels cells, hybridized fuel cells, smart management of energy, power electronics) to improve:
    - cost issues (both on core technologies and balance of plant)
    - aging performances (avoid aging damages, increase lifetime of systems)
    - energy performances : power density i.e. / unit of mass and volume