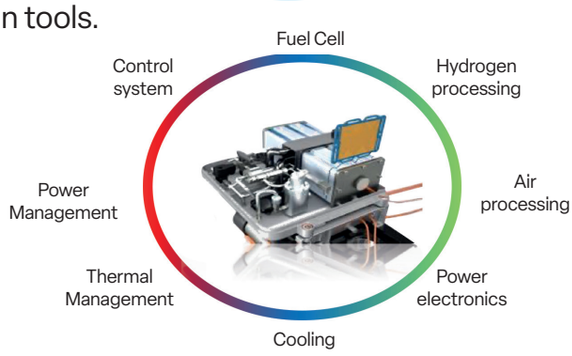
FUEL CELL SIMULATION PLATFORM

FUEL CELL ACTIVITIES

SHERPA Engineering has developed expertise in Fuel Cell activities for automotive and other industries for 25 years. Through multiple R&D projects with Europeans OEMs, we have developed state-of-the-art multi-disciplinary modeling and controls system design tools.

Control system design and **Fuel Cell system diagnosis** are essential engineering tasks.
We have an active role in these tasks when working with our customers, since we take in charge system design process from system specifications until validation on test bench or prototype vehicles.



Our technical fields

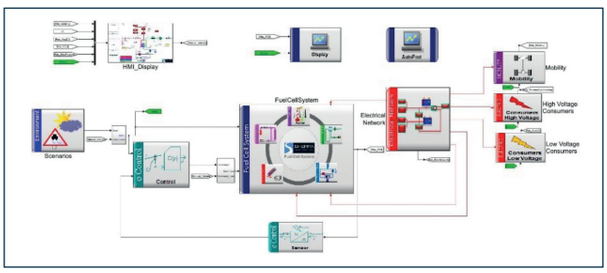
System design
- Requirement definition
- Architecture evaluation and Sizing

Control system design
- Control and default detection of the Fuel Cell power module
- Thermal management
- Power control strategy for Fuel Cell Mobility

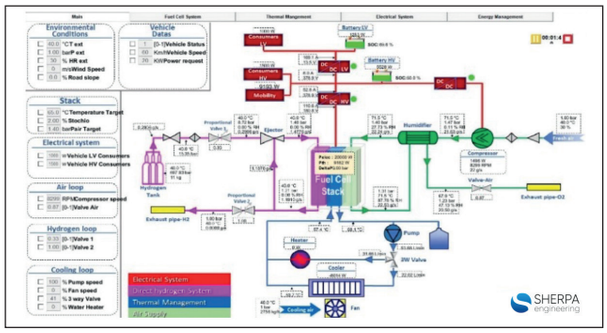
Modeling & simulation
- Fuel Cell stack: Dynamic model
- Component (compressor, pump, humidifier,…)
- Global model: Fuel Cell, cooling, electrical, mobility system

Integration & validation
- Fast prototyping - Model based calibration
- Test specification and requirement validation

Description of the simulation platform



Simulink Model of the Fuel Cell Platform



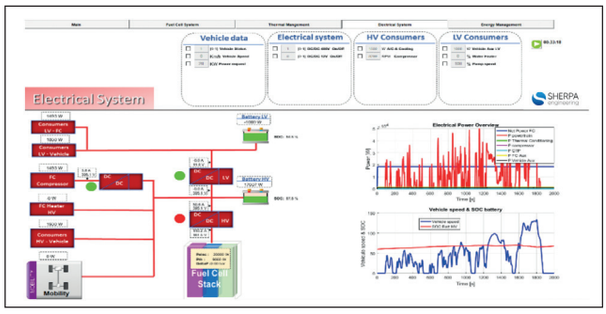
HMI Main Window – Real time visualization

SHERPA Engineering has developed a simulation platform that covers the entire Fuel Cell system including its control logics and its electrical and powertrain environment. The following subsystems are included:

- Air subsystem: supply of the air at the required pressure, flow rate, temperature, and humidity
- Hydrogen subsystem: supply of hydrogen at the required pressure and flow rate
- Cooling subsystem: guarantee adequate cooling of Fuel Cell stacks and ensure small temperature gradient across stacks
- Electrical subsystem: manage the storage and consumption of electrical energy in the various vehicle subsystems.
- Powertrain subsystem: represents the electric mobility powertrain
- Control subsystem: includes basic control laws, diagnosis, monitoring and the system supervisor

Easy to customize / combine multi-physics modeling and control design

You can adapt plant model architecture to your own needs, load your own control software and connect it to plant multi-physics model directly in the platform. We can also deliver to you completely custom-made platforms.

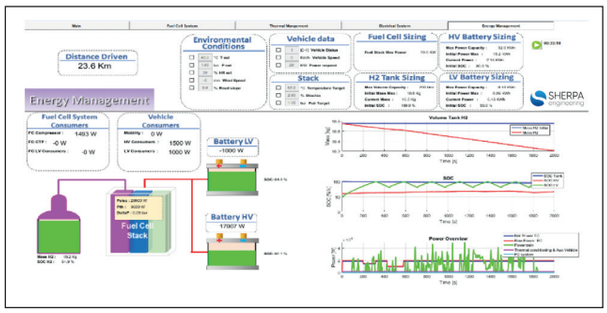


HMI Electrical System Window

Electrical Network allows you to link your Fuel Cell system to different consumers as Low/Hight Voltage and your Powertrain system.

You can easily couple your Thermal Management System to your Fuel Cell system and insure the cooling capacity of whole system.

Energy Management Window allows you to size your components and verify the distance covered under different driving scenarios.



HMI Energy Management Window

System design

We are strongly involved in system design and in the choice of actuators (air compressor, radiator, valves, etc). We ensure the best choice of components using a dynamic environmental model of the system (thanks to Bond-Graph methodology). This model, based on thermofluid equations, considers characteristics of each component, and helps to validate requirements of your system.

Detection of hydrogen leaks

A common safety issue in Fuel Cell systems is hydrogen leaks, which may cause very dangerous faults. In addition to hydrogen sensors, we have developed a method for leaks detection in Fuel Cell systems. This procedure includes a hydrogen storage tank, a primary shut-off valve and a secondary shut-off valve in the supply line.

Diagnosis

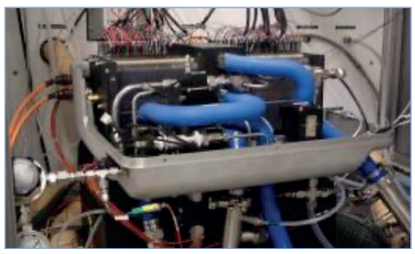
The target of diagnosis systems is to avoid any deterioration of Fuel Cell stacks and to increase their lifespan.
SHERPA Engineering proposes a simple and efficient diagnosis-oriented model. It includes the following three main monitoring modules:

- Cell voltage monitoring
- Vital parameters for a safe and proper operation
- Actuators and sensors diagnosis

Fault detection and identification procedure are based on a reduced model of the Fuel Cell. Residuals (difference between observation and predicted value) are calculated and used to decide on the occurrence of any fault, its type and its location.

Validation process

- Fast prototyping with Simulink and dSPACE systems
- Hierarchical decomposition: using partial bench to validate subsystems before final validation on the entire Fuel Cell system
- Model based design: by running the same tests on model, we anticipate its performance in lab or in real system
- HIL compliance: our models are developed in fixed step and are compliant with real time devices



Bench validation

SHERPA engineering

INGÉNIERIE SYSTÈME, MODÉLISATION MULTIPHYSIQUE, CONTRÔLE-COMMANDE, INTELLIGENCE ARTIFICIELLE

Tél : +33 (0)1 47 82 08 23 - commercial@sherpa-eng.com - www.sherpa-eng.com