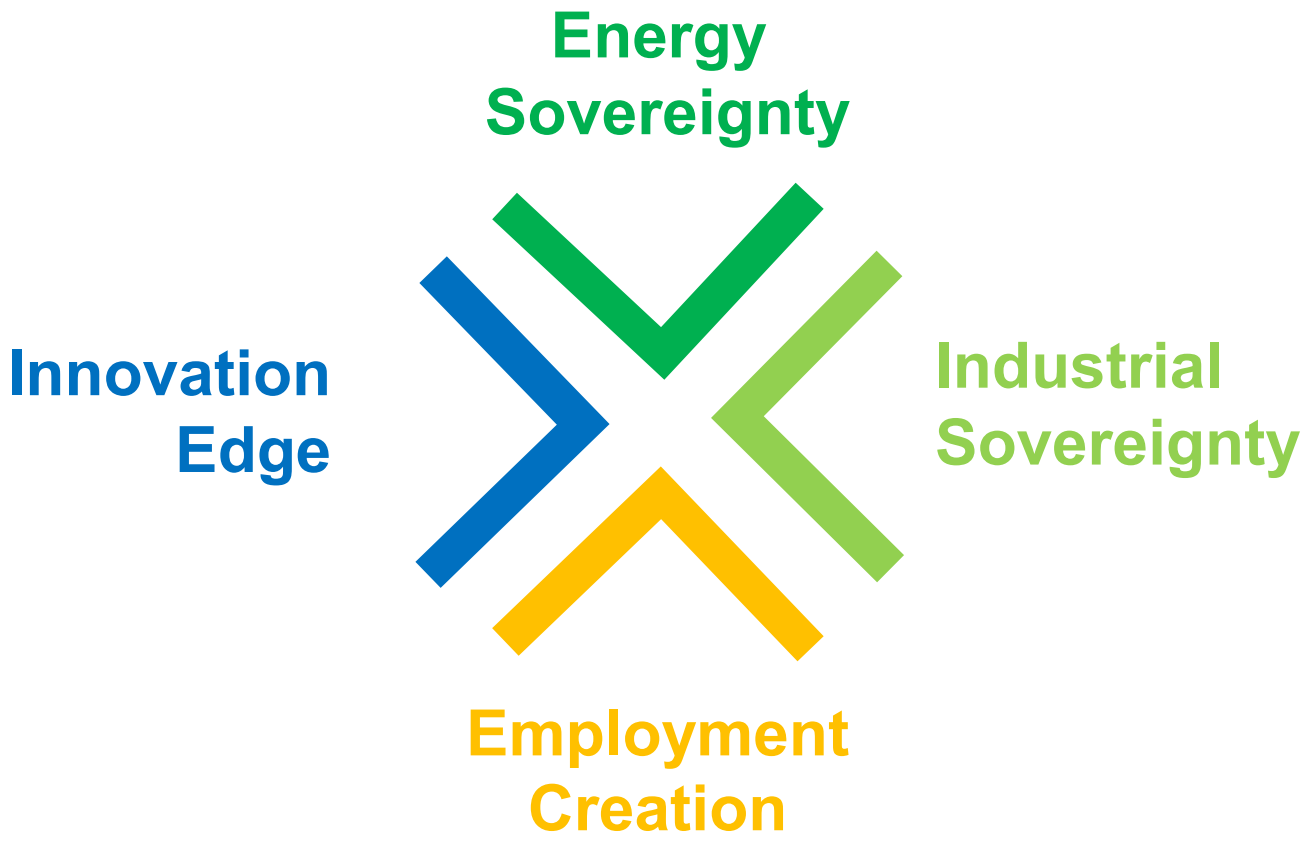
SYMBIO, a global leader in hydrogen mobility

3èmes rencontres Académie - Industrie du CNC

7 décembre 2023 - Maison de la Chimie - Paris

HYDROGEN, A KEY LEVER

To meet today's most compelling challenges



SYMBIO
A FAURECIA MICHELIN HYDROGEN COMPANY

SYMBIO PRESENTATION

Back

Symbio, a front-runner in hydrogen zero-emission mobility combining industrial leadership, cutting-edge innovation and entrepreneurial spirit

Shareholders:
3 major automotive market players

FORVIA faurecia · MICHELIN · STELLANTIS

30 years of experience

+6 million kilometers driven on-road

>750 employees

2021 / 2023	2024 / 2026	2028	2030
1,000-2,500 Syst/Y	**15k-50k** Syst/Y	**100k** Syst/Y	**200k** Syst/Y
Pilot Plant Vénissieux (France)	"SymphonHy" gigafactory Saint-Fons (France)	2 sites in France	Global Footprint (Europe, USA, Asia)

SymphonHy, one of the largest European integrated **fuel cell Gigafactories**

Integrating a world-class innovation center of >100 engineers covering **strategic in-house competencies from stack to complete fuel cell system**

Enabling large scale production up to **50K systems/year** with 4.0 innovative and state-of-the-art process

Over 30 years of experience, an engaged builder of the hydrogen ecosystem

2000 — MICHELIN

2010 — SYMBIO

2019 2020 — SYMBIO, A FAURECIA MICHELIN HYDROGEN COMPANY; FORVIA; MICHELIN

2021 — SYMBIO HYDROGEN ACADEMY; Entry in China and the USA

2022 — INNOPLATE, A Schaeffler Symbio Hydrogen Company

2023 — SYMBIO, A FRONT-RUNNER HYDROGEN COMPANY; FORVIA; MICHELIN; STELLANTIS

and 6 million Km of on-road vehicle experience

STELLANTIS

SAFRA, Accélérateur de mobilité décarbonée

CALIFORNIA ENERGY COMMISSION

GAUSSIN

green corp

Serving strategic markets with international presence

~ 750
HEADCOUNT

3
CONTINENTS

HYMOTIVE

Technological fast-forwarding project Supported by EU's Hy2Tech IPCEI*

€1 billion investment

- ✓ **Accelerate the industrialization and mass production of current FC generation**
- ✓ **Develop and industrialize a new, disruptive generation of FC technology, drastically boosting performance and reducing unit costs**

Manufacturing capacity: 100,000 *units/y in France as of 2028*

Important Projects of Common European Interest

Symbio's HyMotive project is funded by the European Union (NextGenerationEU), and the French Government (France 2030, France Relance)

Financé par l'Union européenne NextGenerationEU

FRANCE 2030

FRANCE RELANCE

bpifrance

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#Trusted H2 Partner

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SYMBIO R&D

Back

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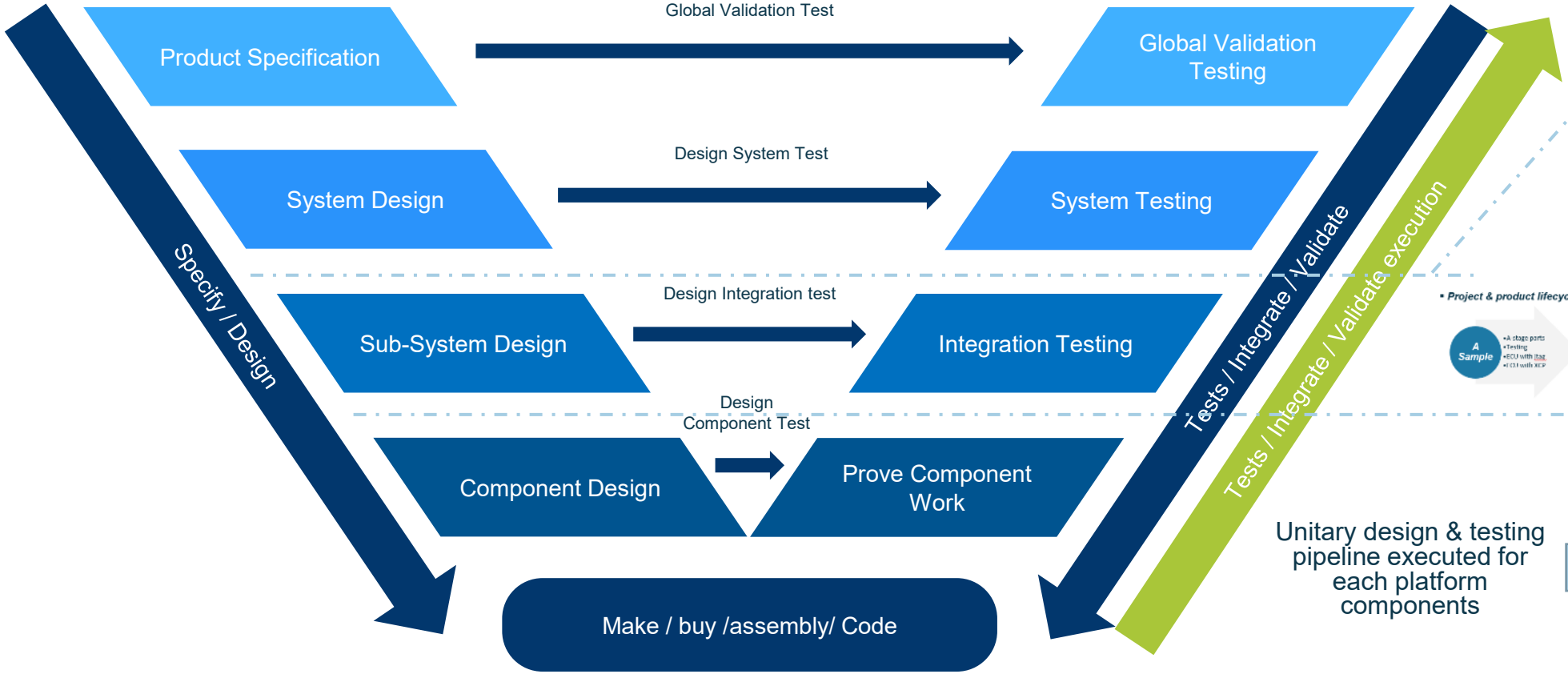
Based on customer specifications we develop and validate Fuel cell systems at each product phases form prototype to Start of production.

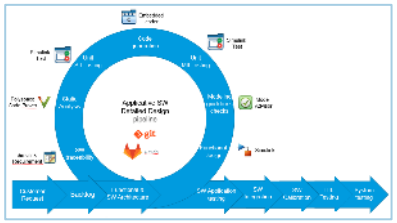
SYMBIO is designing stack and electrochemical core to be integrated in complete system fitting customer expectations.



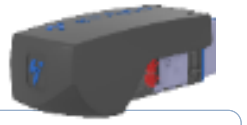
Safety system test always executed

Integration testing method adapted according project/product phase

Unitary design & testing pipeline executed for each platform components



SYMBIO is developing a range of fuel cell Stackpacks according to main customer specifications and request.

STACKPACK	Net Power	Stack Power Density	Stack Cell pitch	Durability
 StackPack 40	**40 kW**	3.9 kW/l (**)	1,4 mm	8.000 h (*)
 StackPack 75	**75 kW**	> 6.5 kW/l (**)	1 mm	8.000 - 30.000h (*)
 StackPack 150	**150 kW**	> 6.5 kW/l (**)	1 mm	8.000 - 30.000h (*)
 StackPack 300	**300 kW**	> 6.5 kW/l (**)	1 mm	8.000 - 30.000 h (*)

* Assumption based on specific duty cycle and hybridization strategies

** End plates and casing excluded

Engineering expertise is crucial and SYMBIO is today well equipped to succeed

An **expertise of the MEA and BPP**, key elements of the fuel cell stack

Strategic in-house competencies: **powertrain sizing/simulation, system architecture, mechanical integration, software, safety…** allowing to offer engineering support services up to turnkey solutions

MEA

- MEA DESIGN AND SPECIFICATION
- MEA RAW MATERIALS ANALYSIS
- MEA BEHAVIOUR IN STACK
- MEA BENCHMARK FROM VARIOUS SUPPLIER

BPP / SEPARATOR

- DESIGN
- FLOWFIELD SIMULATION AND OPTIMISATION
- INDUSTRIALIZATION WITH PARTNERS

SCHAEFFLER SYMBIO

INNOPLATE
A Schaeffler Symbio Hydrogen Company

MECHANICAL DESIGN

- DESIGN ROBUST AND COMPACT SYSTEM AND INTEGRATE FUNCTIONALITIES IN MECHANICAL PARTS
- TAKE INTO ACCOUNT DURABILITY, THERMAL AND MECHANICAL CONSTRAINTS
- AUTOMOTIVE COMPLIANCE

SYSTEM ARCHITECTURE

- SYSTEM SIZING
- COMPONENT SPECIFICATION
- REQUIREMENT MANAGEMENT
- SYSTEM CONSISTENCY
- CONTROL COMMAND RULES

3E EMBEDDED ELECTRIC AND ELECTRONIC

- DESIGN ECU AND HARNESSES
- AUTOMOTIVE AND ISO 26262 COMPLIANT
- SPECIFY DC/DC

SAFETY

- ISO 26262
- HAZOP
- SYSTEM CERTIFICATION

SOFTWARE

- DEVELOP CONTROL SYSTEM SOFTWARE
- ISO 26262 COMPLIANCE
- C AND MATLAB

INTEGRATION & VALIDATION

- SYSTEM TESTING
- BENCH DESIGN

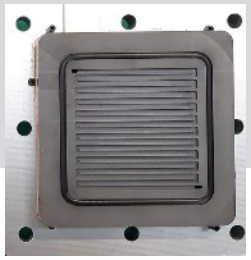
Core fuel cell stack expertise to complete system Expertise

Accelerated stress test are used to speed up durability tests

Fuel Cell

Test 5-25 cm²
single cell

Catalyst AST, cyclic voltage



Polarisation curve,
Chronoamperometry, PEIS
Cyclic voltammetry of cathode & anode, post mortem analysis

Short stack tests

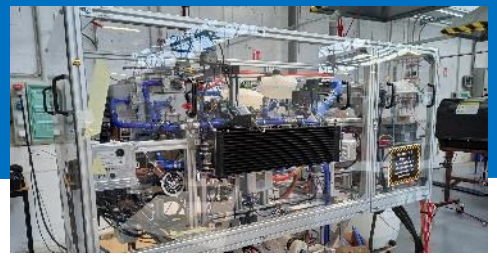
Real format, limited integration

Material AST, cyclic voltage

Full system

Real format, full integration,

System AST, complex cycle



Complete vehicle

field test

Development loop with reliable data for design orientation

Next decade R&D chalenges

Back

Hydrogen fuel cell system challenges and leverages

	Today	2030	2040
COST	**Proto / low production : Expensive**	**Industrialized product : ~ 50 €/kW**	**Mature industrialized product : < 30 €/ kW**
	• Reuse existing raw materials and components • Optimize system control	• Optimize Fuel cell system PID • Catalyst loading < 0,2 mg/cm2 (A+C) • Reduce ionomer and catalyst support cost	• PEM Fuel Cell ultimate PID • PGM free catalyst • Low-cost PFSA free ionomer or alternative
PERFORMANCE	**0,7V@1A/cm2,85°C,5000h, -20°C**	**0,75V@1,5A/cm2,105°C,30000h, -30°C**	**0,8V@2A/cm2,140°C,50000h, -30°C**
	• Optimize operating conditions • Optimize system control laws vs duty cycle • Intimacy with key suppliers	• Optimize key component engineering • Degradation mitigation : catalyst and support, ionomer, BPP corrosion. • System optimization for High Temp	• High temp resistant polymer and ionomer • Ionic conductor, %RH free • Breakthrough technologies
SUSTAINABILITY	**Pain points understood**	**Bring a sustainable solution to market**	**Best in class**
	• FC technology analysis and assessment • Benchmark vs alternative (Batteries, ICE …)	• Reduce catalyst PGM loading • Reduce PFSA usage • LCA fully analyzed and shared	• Zero PGM • Zero PFSA • Competitive LCA vs ICE or BEV

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BUILDING A POSITIVE FUTURE