SYENSQO
ADVANCING HUMANITY

Advanced Materials for the H_2 Transition

Meet our explorers

November 19th

Click to play the video

WELCOME

WE CREATE
TODAY

SYENSQO

Competition law - **Guidelines**

1

Adhere to Competition Law

Conduct all discussions in compliance with competition law; avoid sharing any business-sensitive information or coordinating responses to third parties.

2

Avoid Commercially Sensitive Topics

Do not discuss non-public information related to pricing, marketing strategies, R&D, trade terms, or other areas that could impact competition.

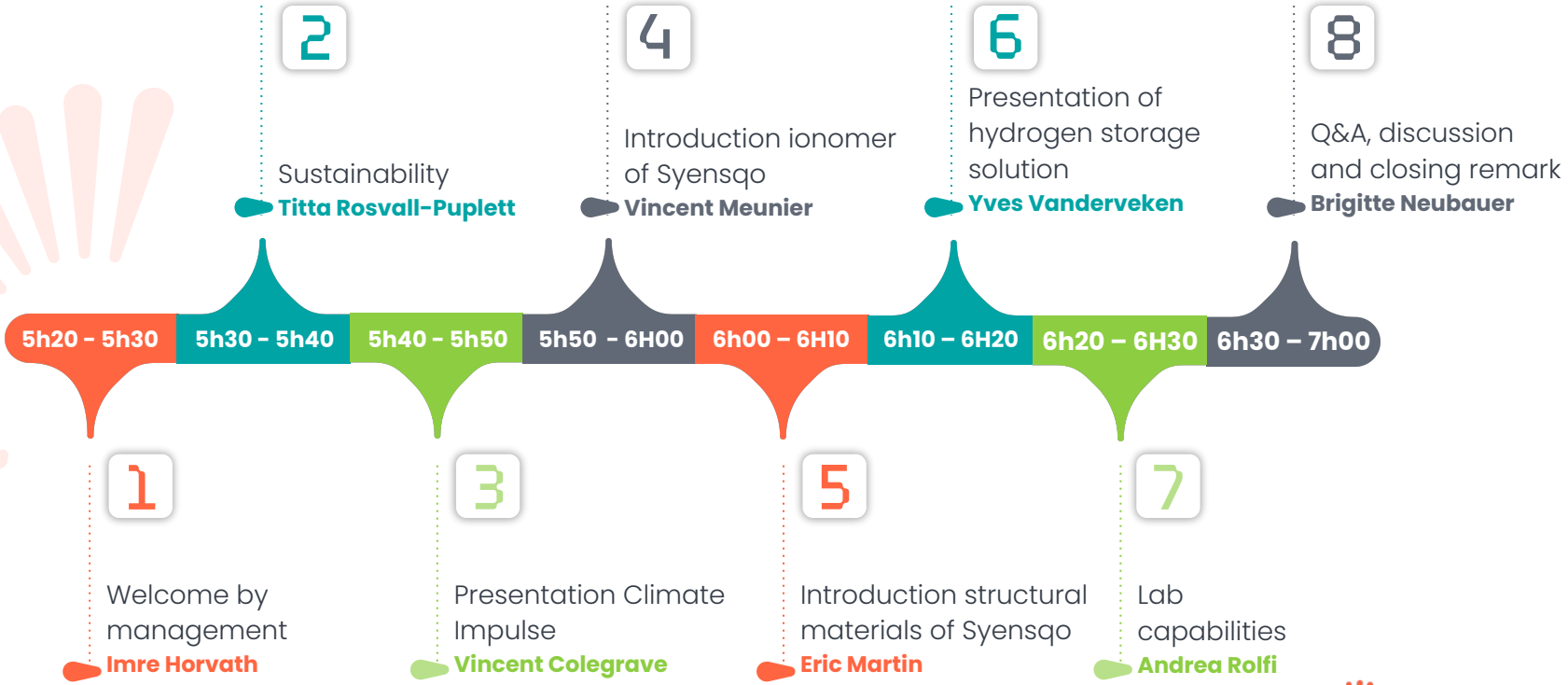
3

Seek Guidance if in Doubt

If unsure about any topic appropriateness, consult legal advice. Syensqo may halt discussions if competition law risks are identified.

SYENSQO

Agenda



SYENSQO

SPEAKER 1

IMRE Horvath
Director Green Hydrogen Platform

SYENSQO

QUESTION?

How can partnering with **SYENSQO** help you accelerate the **hydrogen economy**?

SYENSQO

Top-tier **specialty player**

~13,200
Employees

62
Industrial sites

12
Major R&I centers

€6.8bn
Net sales

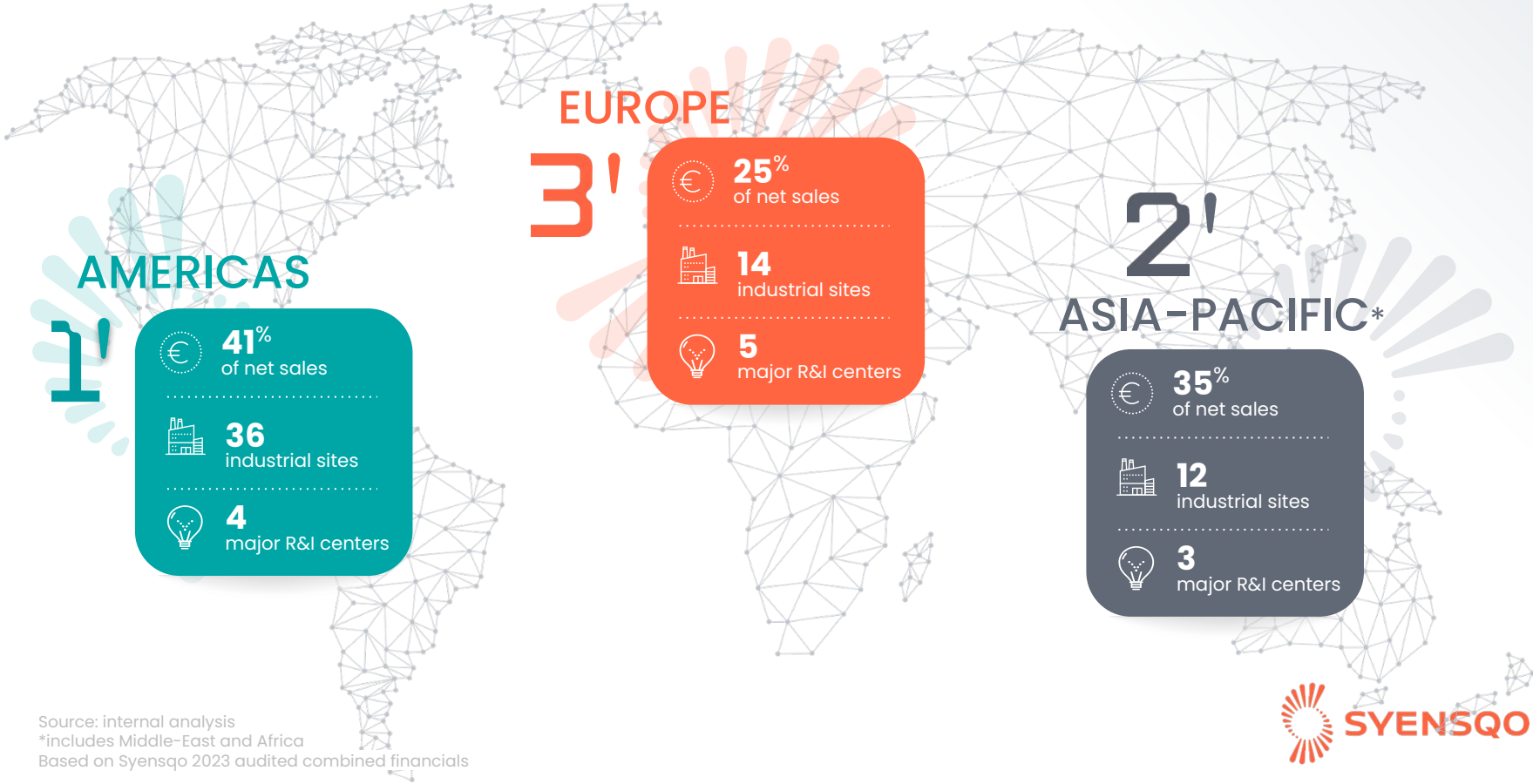
€1.6bn
Underlying EBITDA

23.7%
Underlying EBITDA margin

2023 Syensqo audited combined financial statements
FTE figures as of March 31st 2023

SYENSQO

Global and close to our **customers**



AMERICAS

1'

41% of net sales

36 industrial sites

4 major R&I centers

EUROPE

3'

25% of net sales

14 industrial sites

5 major R&I centers

ASIA-PACIFIC*

2'

35% of net sales

12 industrial sites

3 major R&I centers

Source: internal analysis
*includes Middle-East and Africa
Based on Syensqo 2023 audited combined financials

SYENSQO

Ideally placed to leverage disruptive trends

Electrification

Leader in specialty materials for Li-Ion batteries and fuel cells

Lightweighting

Broadest portfolio of advanced materials

Advanced Connectivity

Advanced materials for semiconductor and smart devices

Resource Efficiency

Mining reagents and solvents to recycle end-of-life batteries

Improving Quality of Life

Leader in hemodialysis media, green solvents and crop protection

Green Hydrogen

Broadest portfolio of materials in all the value chain for electrolyzers, fuel cells and other facets of hydrogen systems

Source: Management reports, internal estimates

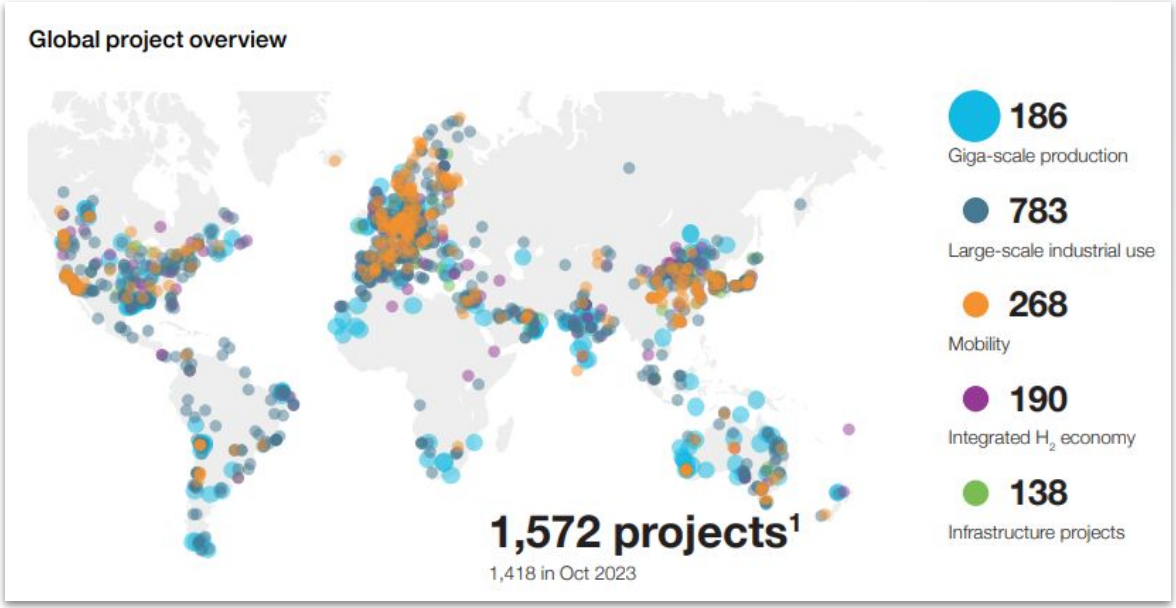
Overall strong hydrogen economy momentum

with the market taking a breather - fundamentals unchanged

GARTNER HYPE CYCLE

Where is H2?

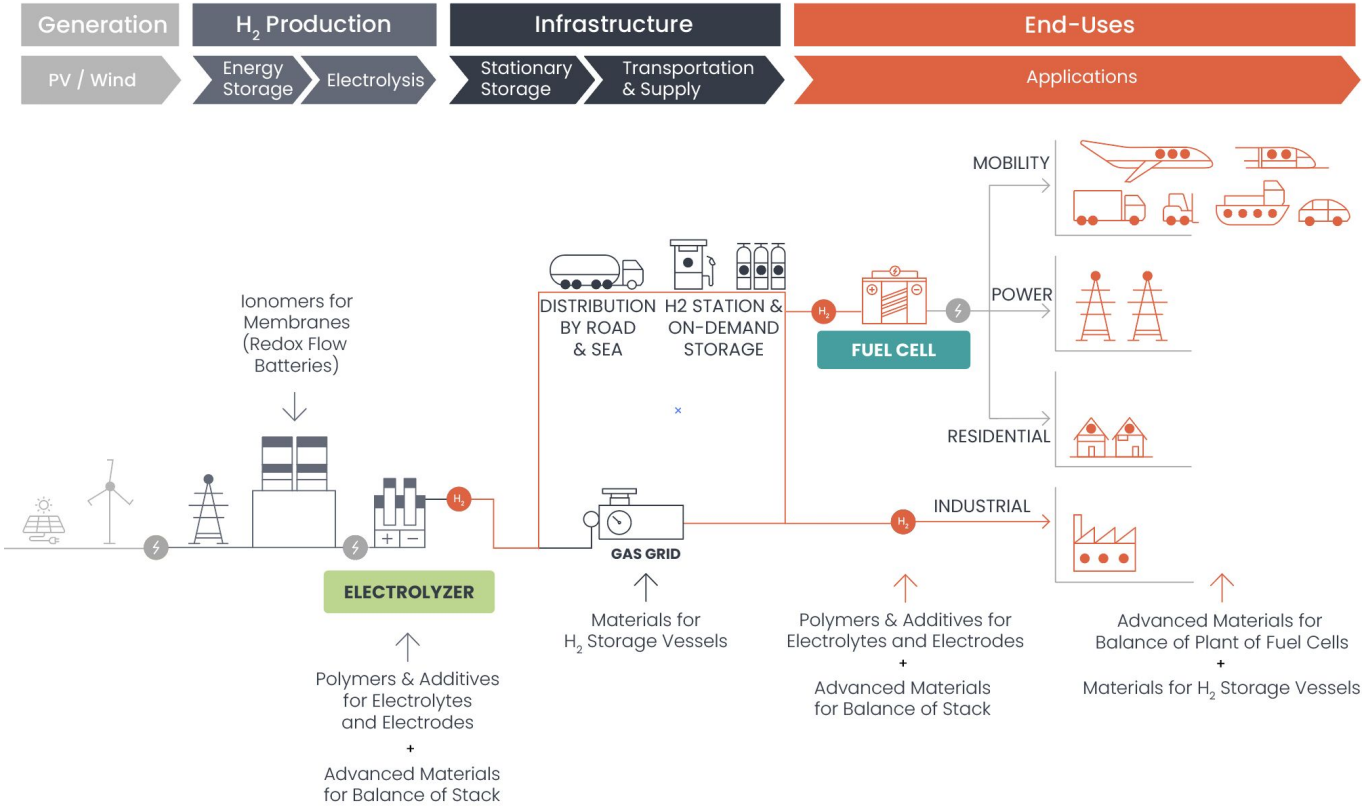
From slope of enlightenment to plateau of productivity



Source: Hydrogen Council, Hydrogen Insights September 2024

SYENSQO

Serving our customers with relevant products & solutions all along the Green H_2 value chain



Connected to key hydrogen associations, incl.

Hydrogen Council

Hydrogen Europe

SYENSQO

SPEAKER 2

Titta Rosvall-Puplett
Chief Sustainability Officer

SYENSQO

QUESTION?

What are the **BEST STRATEGIES** for fostering **collaboration** among BUSINESSES on **SUSTAINABILITY INITIATIVES?**

SYENSQO


Carbon Neutral by
2040
10 Years earlier than our previous commitment
SYENSQO

Sustainability is integrated in everything we do and we are progressing on our ambitions

CLIMATE

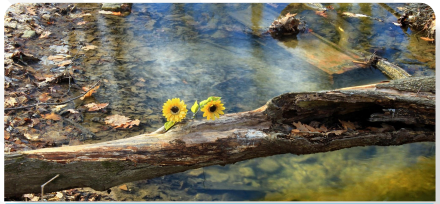
Carbon Neutrality by 2040

40% reduction
Scope 1 & 2
by 2030[1]

20%
structural reduction versus 2021 baseline

23% reduction
Scope 3 Focus 5[1,2] emissions
by 2030

11%
structural reduction versus 2021 baseline



NATURE

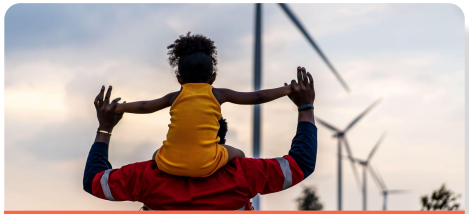
Freshwater intake
by 2030

20% reduction
Sites exposed to water availability challenges
by 2030[1]

GROWTH

18% of Circular sales
by 2030[3]

13%
+1% point versus 2021



BETTER LIFE

Safety
Aim for zero RIIR[4]

38%
reduction versus 2021

Gender parity
by 2033[5]

28%
+4% points versus 2021

Living Wage
by 2026

SYENSQO

Journey of collaboration

2019

- Global Internal Carbon Price = 2x European Price

2020

- Paris Accords
- One Planet
- Biodiversity Act For Nature
- CSR Europe
- Wildlife Habitat Council
- Citizen day on Environment

2021

- Carbon neutral by 2050
- Ellen MacArthur Foundation
- Citizen Day on Biodiversity
- ESG Board Committee

2022

- Scope 3 2030 target
- Pressure on biodiversity reduced by 28% since 2018

2023

- 1.5°C Commitment CDP A-
- SBTI validation Well below 2°C
- Scope 1+2 reduction 2x Paris since 2018
- China & US 100% powered by renewable electricity
- Accelerated carbon neutrality by 2040

YTD 2024

- Formula E
- Antwerp declaration
- Climate Impulse
- UNGC 10 Principles
- Kallo-Beveren 1st carbon neutral site
- 3 sites to be certified by Wildlife Habitat Council

NEW TARGET!

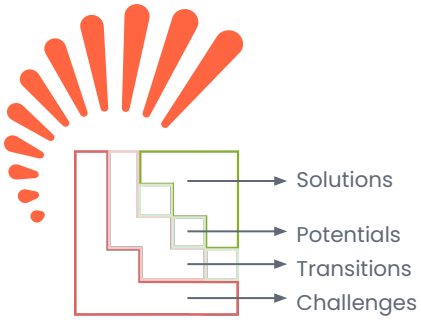
- fresh water intake reduction target
- ESG Training sessions for the BoD
- Renewable Carbon Initiative
- Europabio
- Together for Sustainability

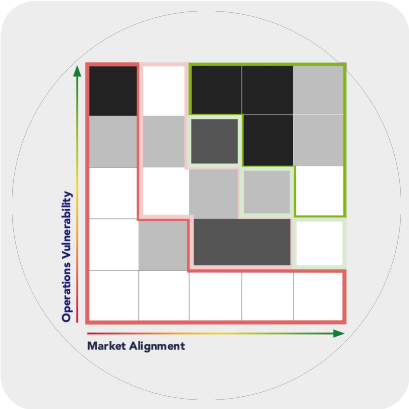
Achievements before 2023 are Solvay and Syensqo combined


We ADVANCE
your company
on sustainability
SYENSQO

Sustainable Portfolio Management is critical compass to guide our businesses decisions and helping to manage risks and opportunities in the value chain

Supplies → Syensqo → Customers → Brand Owners → Consumers → Sustainability, Biodiversity & Circular Economy imperatives move up the value chain





Sustainable Portfolio Management (SPM)

A strategic tool to detect market signals for Sustainability & CE

Systematic
Fact Based
Future Oriented
Customer Centric

→ New Market Signals!

SYENSQO

SPEAKER 3

VINCENT Colegrave
Head of Syensqo.ai

Climate Impulse
Partnership Director

SYENSQO

QUESTION?

How can even the most **challenging industries** adopt **CLEANER TECHNOLOGIES** like **H_2**, fast?

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Click to play the video


CLIMATEimpulse
SVENSQO
“Once you choose hope, anything’s possible.”


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One Flight | One World | Zero Emissions
SYENSQO
ADVANCING HUMANITY
Aviation **strives to be compatible** with ambitious climate objectives


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SYENSQO
ADVANCING HUMANITY
How can we make air travel
more sustainable?


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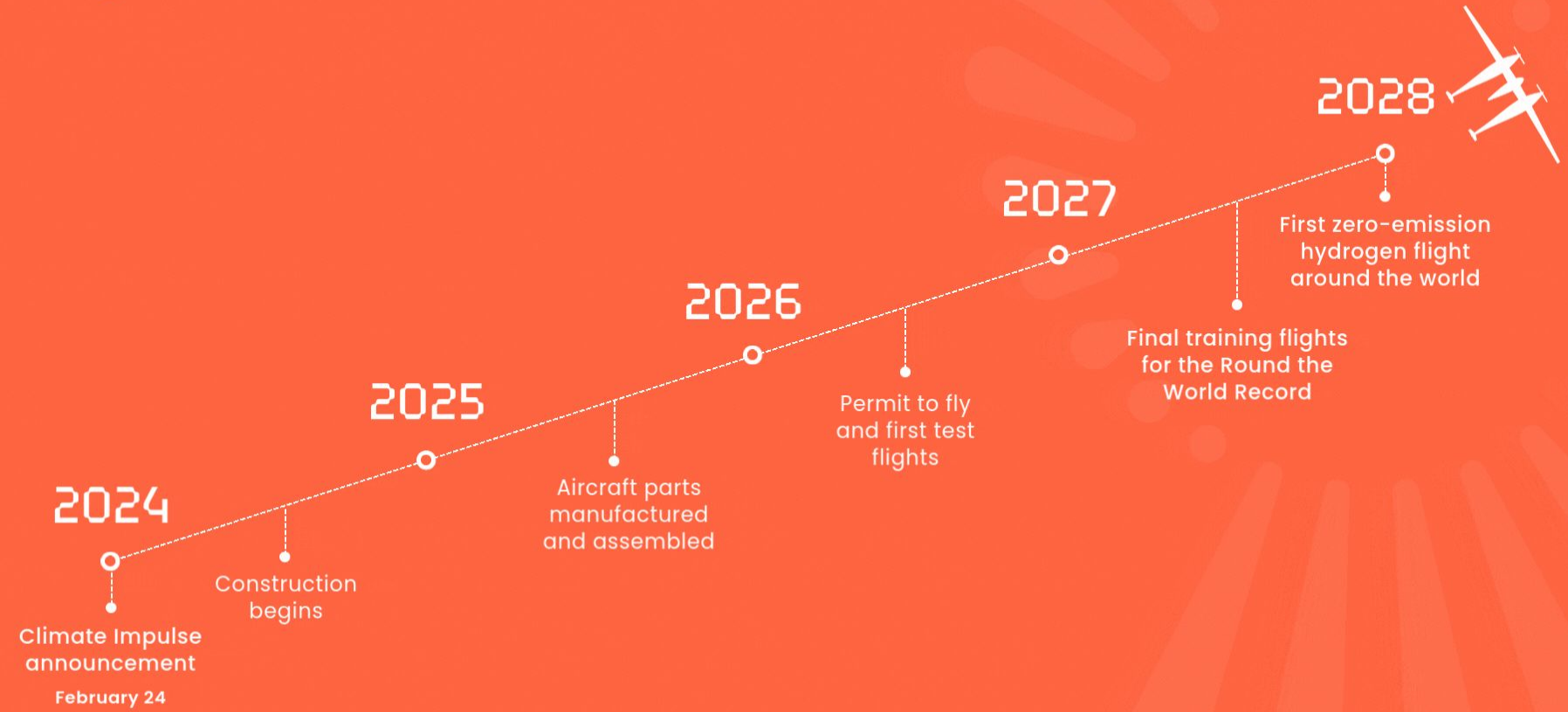
SYENSQO
ADVANCING HUMANITY
Climate Impulse
is here to show the way

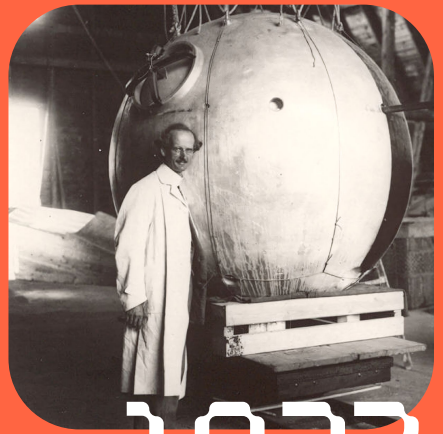
A **flight around the world** in 2028



CLIMATEimpulse
One Flight | One World | Zero Emissions

SYENSQO
ADVANCING HUMANITY

A Century of **Collaboration**



1927

2016

2024

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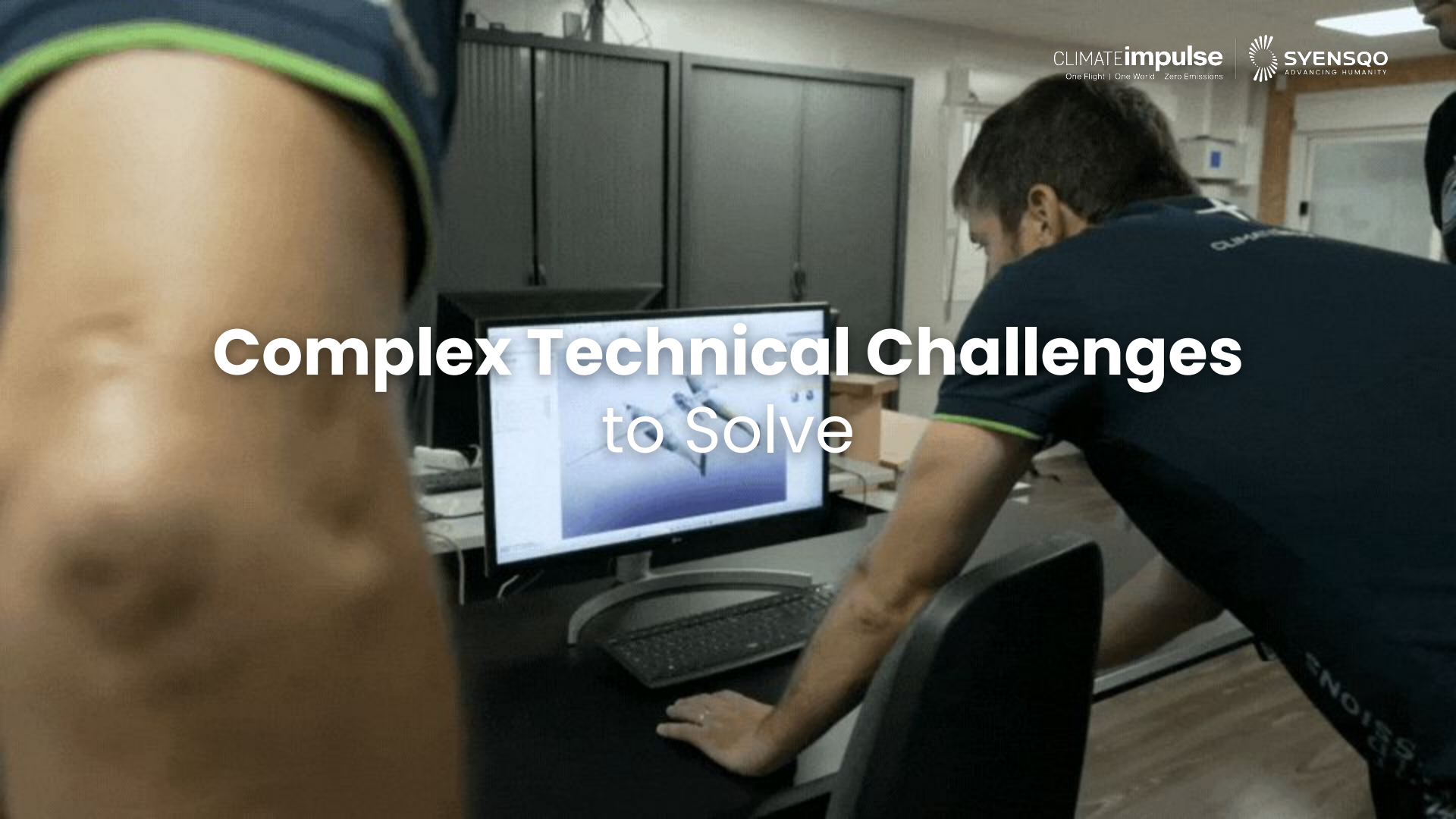
SYENSQO
ADVANCING HUMANITY

A Legacy of Bringing Together the Brightest Minds



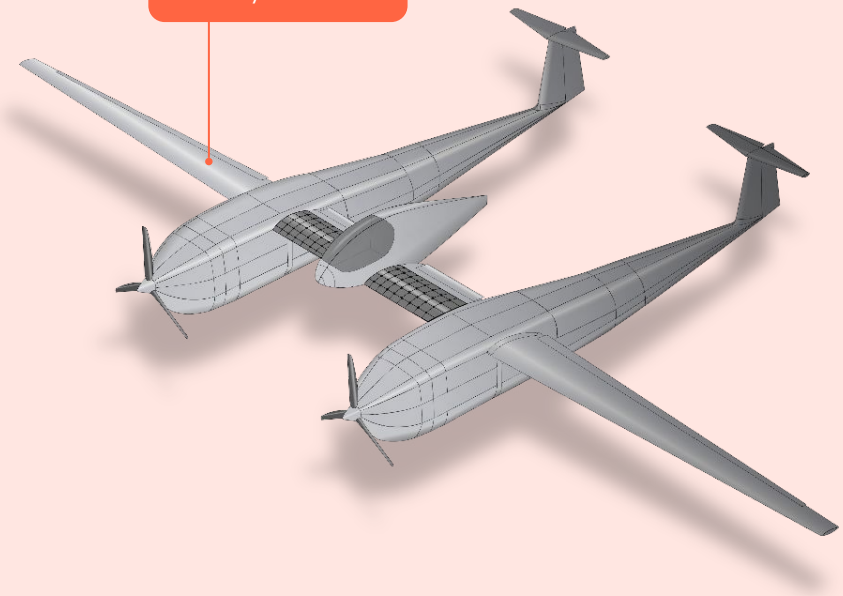
Complex Technical Challenges to Solve

Challenge:
Weight

Solution: **Composite Materials**

Fuselage, Wings, Cockpit, Pods

Composite Material
MTM®45-1 PrePreg
FM® 209-1 Resin
* FusePly®



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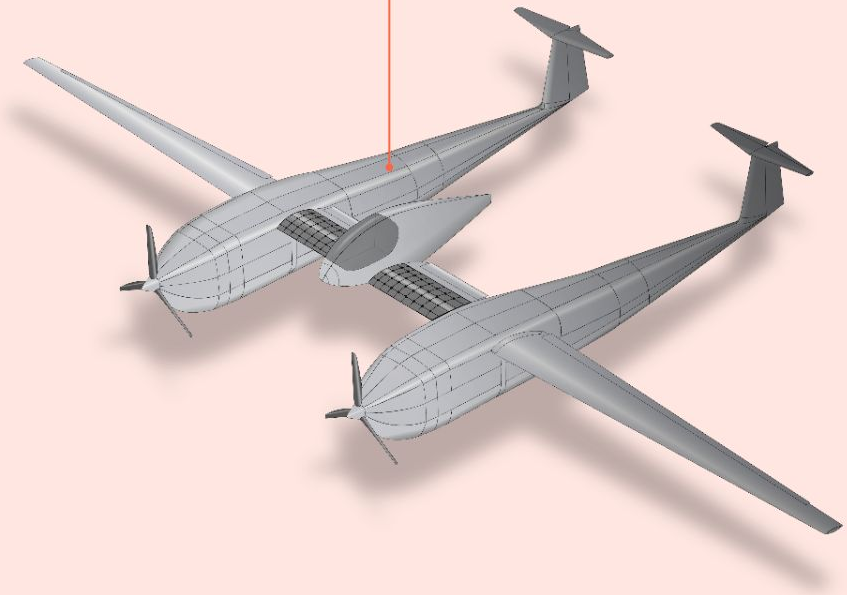
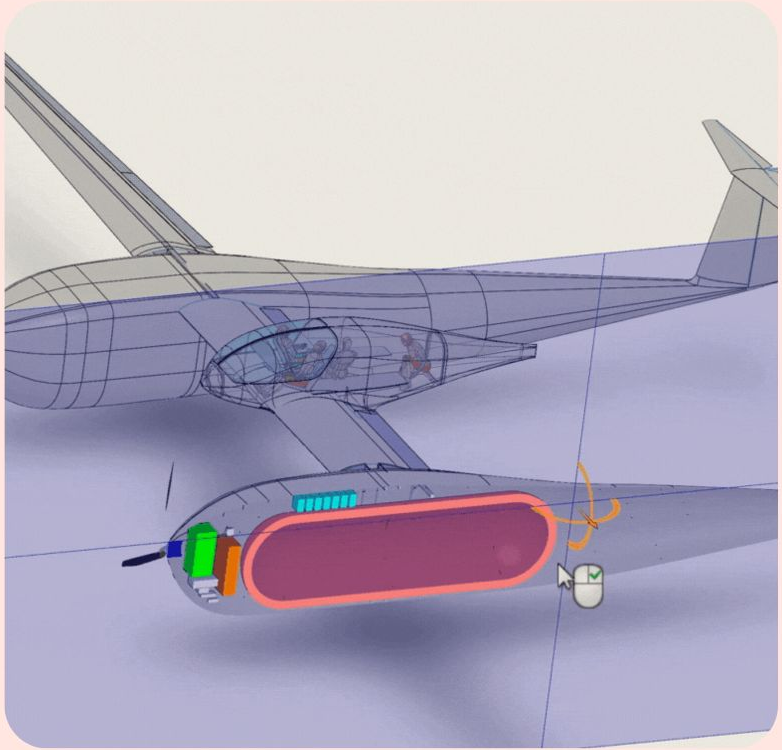
Challenge:
Liquid Hydrogen Storage

Exploration: **Advanced Epoxy Resin and Composite Materials**

LH2 Tank

Composite Material
Reservoir
Cycom® 5320-1, * APC-2 PEEK





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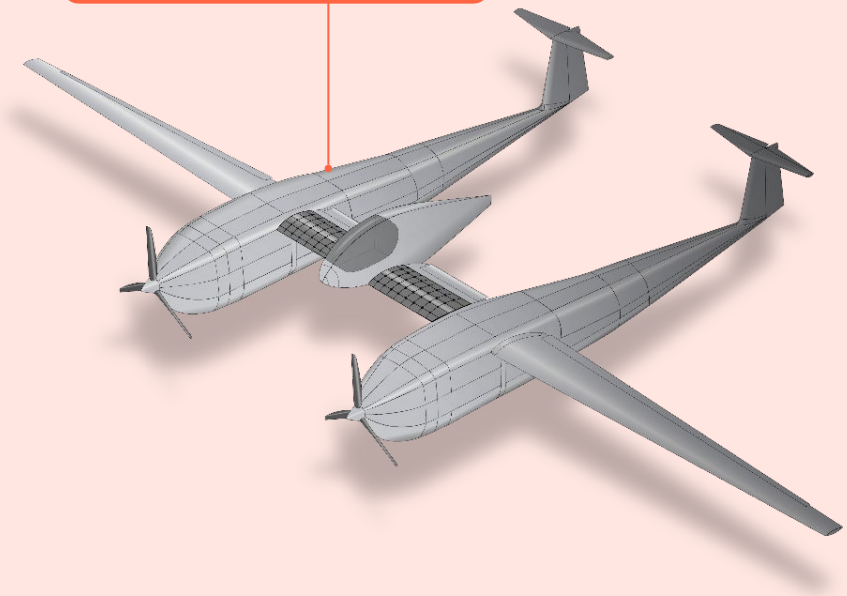
Challenge:
The Fuel Cell

Solution: **The Right Balance of Weight & Power**

Fuel Cell

Specialty Polymers
Membrane & Stacks components
* Aquivion®
Radel® PPSU, * Torlon® PAI

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Extraordinary Challenges
Demand Extraordinary Solutions

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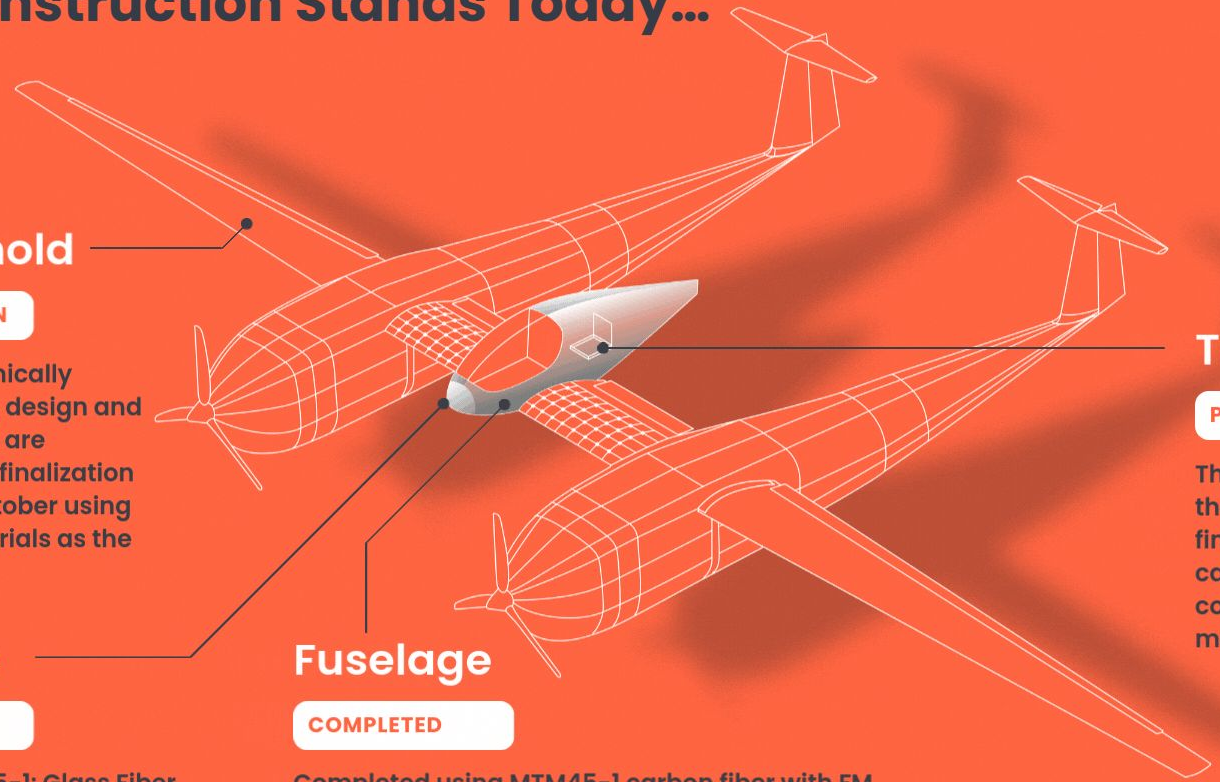
Where Construction Stands Today...



Wings mold

IN PRODUCTION

The aerodynamically optimized wing design and layup selection are complete, with finalization planned for October using the same materials as the cockpit.

Trapdoor mold

PROTOTYPE

The position and shape of the hatch have been finalized, and the first carbon prototype is complete, using the same materials as the cockpit.

Radome

COMPLETED

Material MTM45-1: Glass Fiber fabric impregnated with resin.

Fuselage

COMPLETED

Completed using MTM45-1 carbon fiber with FM 209-1 resin films; frame supports design, fabrication, and internal sealing are ongoing.

Status as of September 1, 2024

SPEAKER 4

VINCENT Meunier
Head of Commercial &
Business Development
Green Hydrogen Platform

SYENSQO

QUESTION ?

MATERIALS ENABLING HYDROGEN TECHNOLOGY

What can be expected from

IONOMERS

The **ADVANCED MATERIALS**

at the core of **H_2-Tech**?

SYENSQO

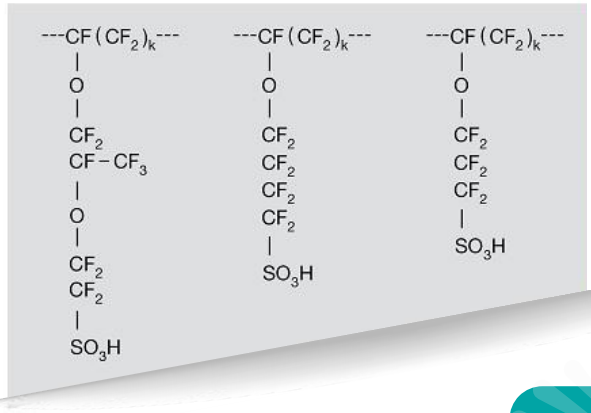
Introducing Syensqo's Aquivion® ionomer

An exceptional functional ionomer

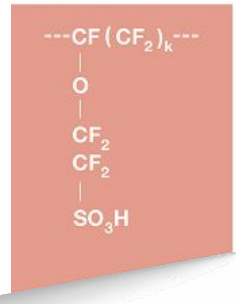
Aquivion® fluoro-ionomer

broadens the technical choices of both PEM fuel cells and PEM electrolyzer cells developers.

Long-Side Chain



Aquivion® - SSC



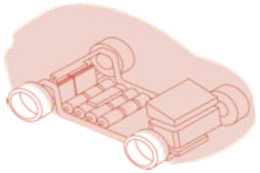
→ **Syensqo's short side chain sulfonic acid-functionalized perfluoropolymer** differentiates itself from incumbent "PFSA's"

25+ years
of Aquivion® legacy

SYENSQO

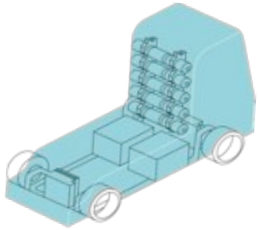
Exceptional functional ionomers
for the right applications

Continuous optimization & adjustments of the Aquivion® fluoro-ionomer product portfolio inline with market developments



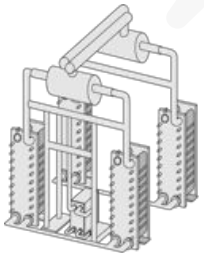
SINCE **2000**

Initially designed to excel in **Passenger cars**



SINCE **2019**

Transportation sector shifting FC-focus towards **Heavy Duty vehicles**



SINCE **2022**

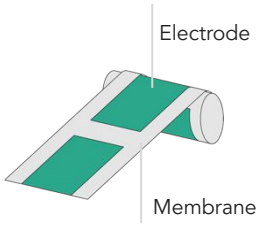
Increasing urgency for GW-scale pathways for industrial **Green Hydrogen production**

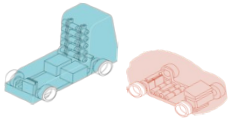
Clear positioning in the value chain to nurture regional creativity of PEM and MEA developers

SYENSQO

Exceptional functional ionomers "made the right way"

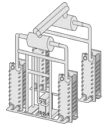
An updated and mature portfolio of Aquivion® fluoro-ionomer dispersions ready since 2022…





EW 720, 790 or 980
Depending of CCM/MEA operation conditions

EW 720 or 790
Complemented by radical scavenger when needed



EW 790 or 870
IrO2 and Pt/C

EW 870 or 980

KEY BENEFITS

- **High-temperature stability** → Low creep or reduced cell resistance
- **Higher crystallinity** → Good mechanical stability and low hydrogen crossover rate as enablers for thinner membranes
- **Different and Low equivalent weight** → Optimum balance of conductivity/ mechanical properties

… continuously improving

06/2022

Syensqo (formerly known as Solvay) announces phase out use of fluorosurfactants globally
Nearly 100% of fluoropolymers portfolio on NFS technology by 2026

11/2024

Launch of Aquivion® N+ series and introduction of Aquivion® N+ 125D
Aquivion® fluoro-ionomers based on non-fluorosurfactant production technology

MORE IONOMERS TO FOLLOW …

SYENSQO

Exceptional functional ionomers **for the future**

Where technically durable and leading to further value-added innovation we support our customers to

- Reduce the Product **Carbon Footprint** of Aquivion® N+
- Identify **fluorine-free alternatives** for selected end use sub-segments

SYENSQO

SPEAKER 5

ERIC Martin
Global Technical Marketing Manager
Green Hydrogen Platform

SYENSQO

QUESTION?

MATERIALS ENABLING HYDROGEN TECHNOLOGY

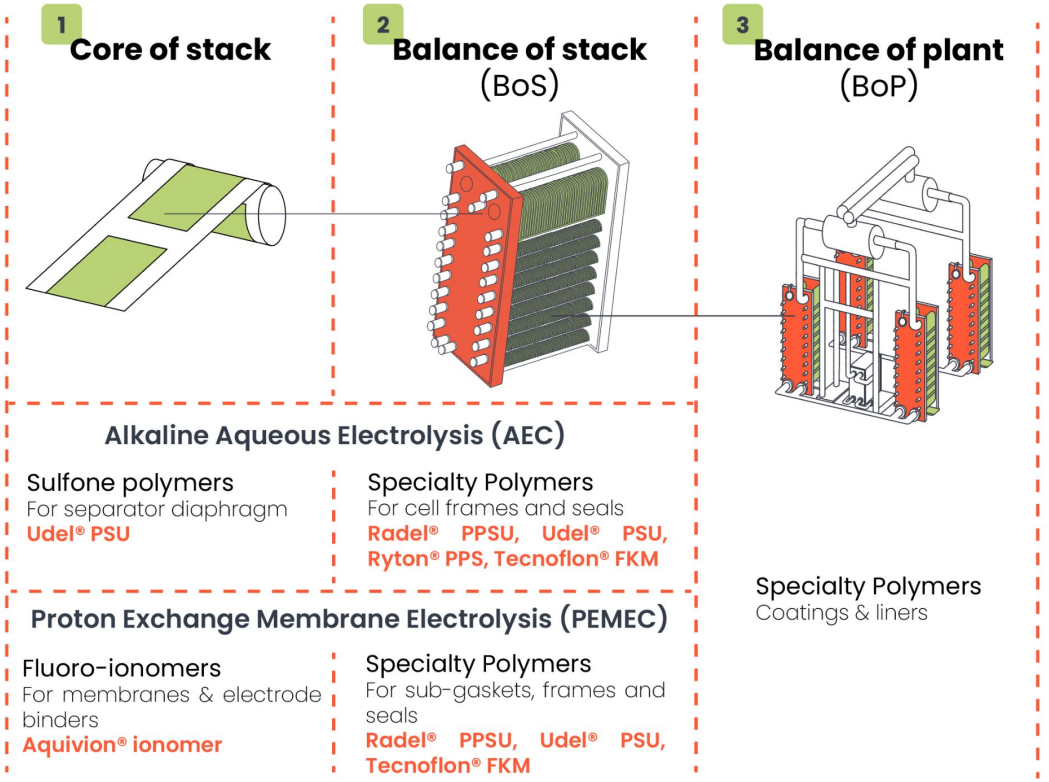
How can **MATERIAL SELECTION** contribute to better **EFFICIENCY** and **DURABILITY** of **H_2 technology systems?**

SYENSQO

Syensqo's Advanced Materials relevant and meaningful in electrolysers to produce Green H_2

INDUSTRY TRENDS

- Higher performance & efficiency
- Durability to reach required lifetime
- Lightweighting
- Cost effective production scale-up



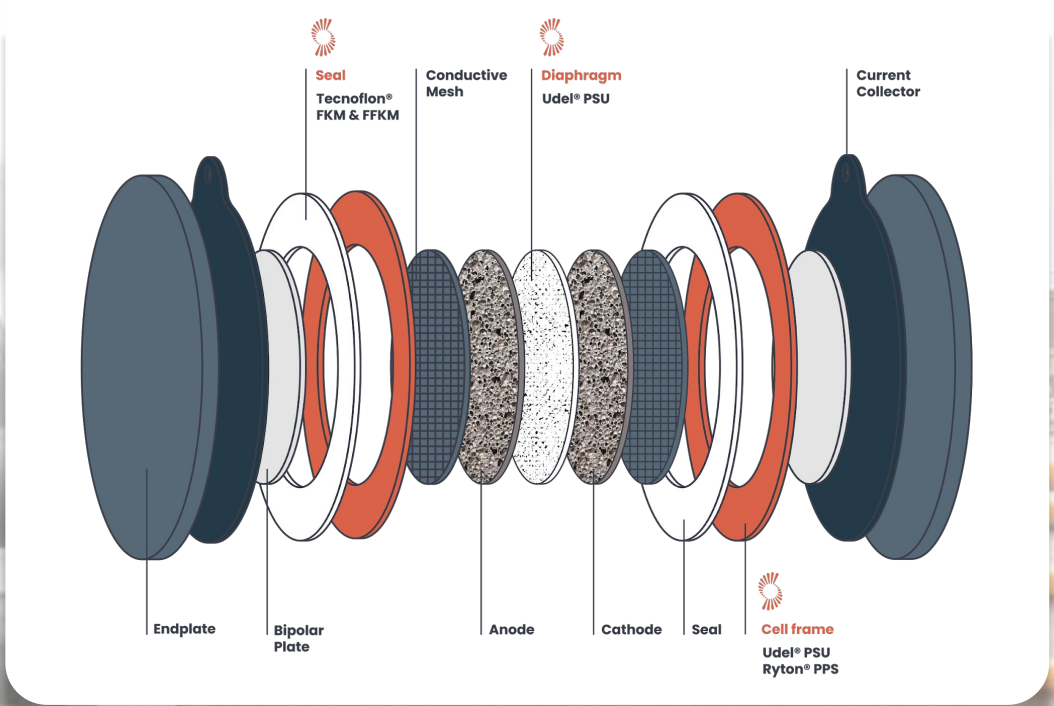
SYENSQO

Deep-dive in one key application
Alkaline Electrolyser Cell Frame

FUNCTIONS

Frames enable to :

- → protect the electrochemical components
- → bring the structural stability to the stack
- → drive the gas/fluid management
- → improve efficiency
- → actively contribute to the sealing performances



Syensqo

Tech Support

Alkaline Electrolyser Cell Frame

Materials Solutions

Requirements

- → High specific stiffness
- → High compressive strength
- → Very low deflection under load, up to 120°C
- → No corrosion in alkaline environment
- → Extremely high chemical resistance
- → Rheology designed for large complex shape & series production

Drivers for plastics Optimize Design and Reduce Thickness

- → Durability (corrosion)
- → Lightweighting
- → Heat management
- → Flexible manufacturing

Chemical Resistance

Chemical ageing in KOH
ESCR in KOH

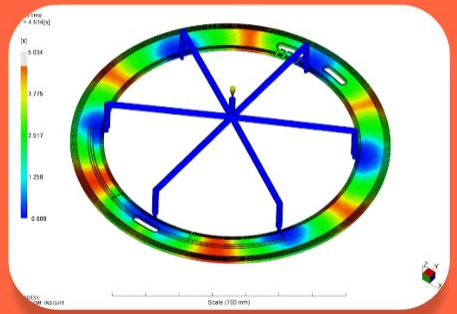
Mechanics

Short term
Long term (creep…)

Simulation / CAE

Moldflow
Mold/Part Design

Digimat
Mechanical stress & deformation in operation



SOLUTIONS

Udel® HYRA PSU / Radel® HYRA PPSU

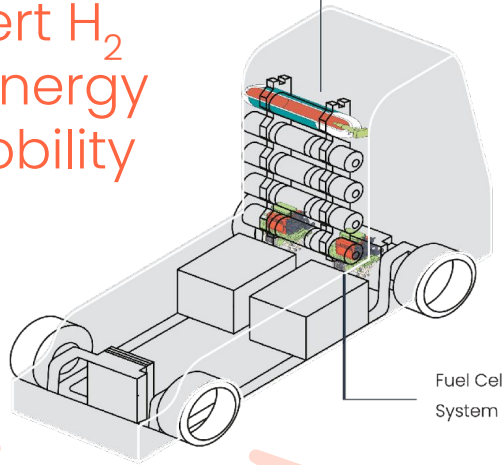
- >10y track records in AE
- Amorphous
- Excellent stability at high pH and T
- High stiffness

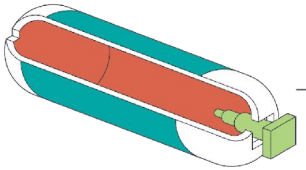
Ryton® HYRA PPS

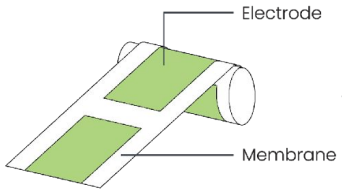
- Semi-crystalline
- Outstanding dimensional stability
- Excellent chemical resistance

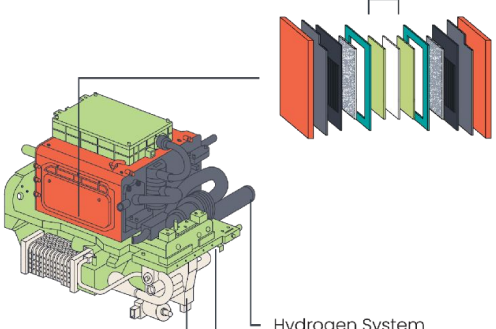
SYENSQO

Syensqo's Advanced Materials to store H_2 and convert H_2 into energy for Mobility









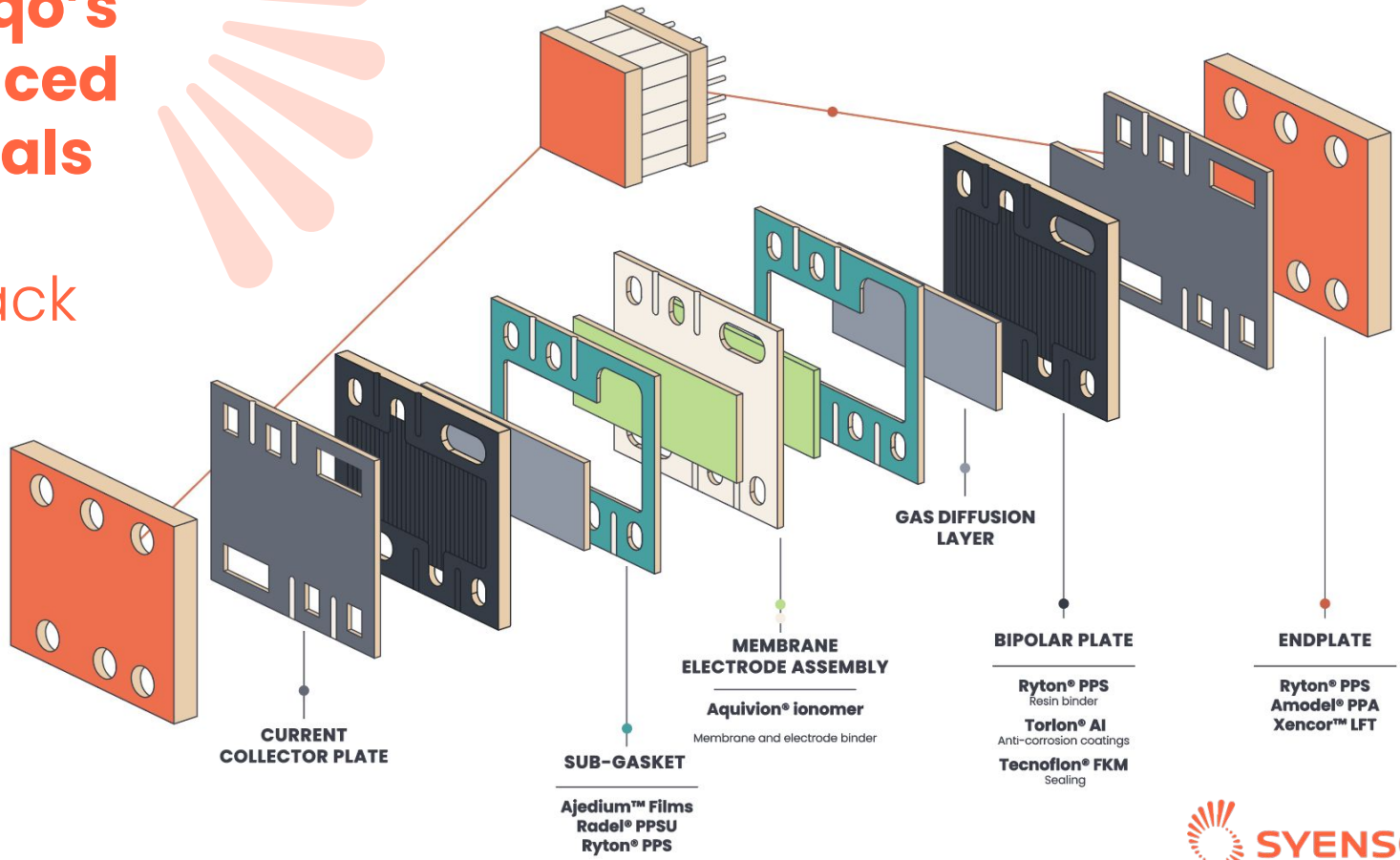
Specialty Polymers

Fluoro-ionomers
For membranes & electrode binders
Aquivion ® ionomer

Specialty Polymers & Films
For sub-gaskets, bipolar plates, sealings, endplates
Radel® PPSU, Ryton® PPS, Amodel® PPA, Torlon® AI, Tecnoflon®, FKM, Xencor™ LFT

Specialty Polymers
For hydrogen, air and thermal managements loop applications
Ryton® PPS, Amodel® PPA

Syensqo's Advanced Materials for fuel cell stack



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SPEAKER 6

YVES Vanderveken

Project Leader Structural Materials for Hydrogen Tanks

SYENSQO

QUESTION?

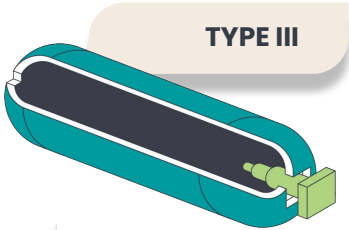
MATERIALS ENABLING HYDROGEN TECHNOLOGY

What **CHALLENGES** is Syensqo addressing to **bring hydrogen storage “at scale”**?

SYENSQO

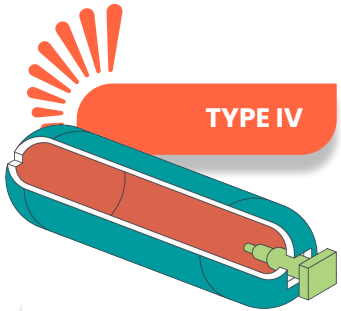
Challenges for H_2 tanks – Opportunities for Syensqo Materials

Types of H_2 tanks



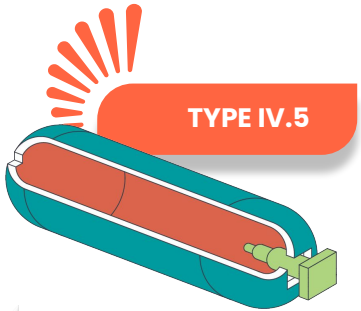
TYPE III

Steel or aluminium liner
Composite full wrap



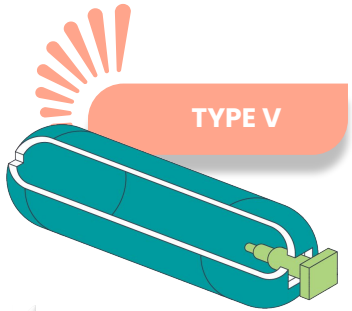
TYPE IV

Plastic liner
Composite full wrap



TYPE IV.5

Plastic liner
Thermoplastic Composite wrap with similar polymer matrix



TYPE V

No liner
All composite

Challenges

A Fast fueling of 700 bar tanks

Safe tank resistant to **T peaks > 85 °C**

B Reducing H_2 contamination

Lower H_2O absorption of liner vacuum resistance (type IV.5 tank)

C Less H_2 release, better LCA, recyclability

Low H_2 permeation, better use of carbon fiber, full thermoplastic tank

D Design efficiency

Store more H_2 with less weight
Better use of available volume

SYENSQO

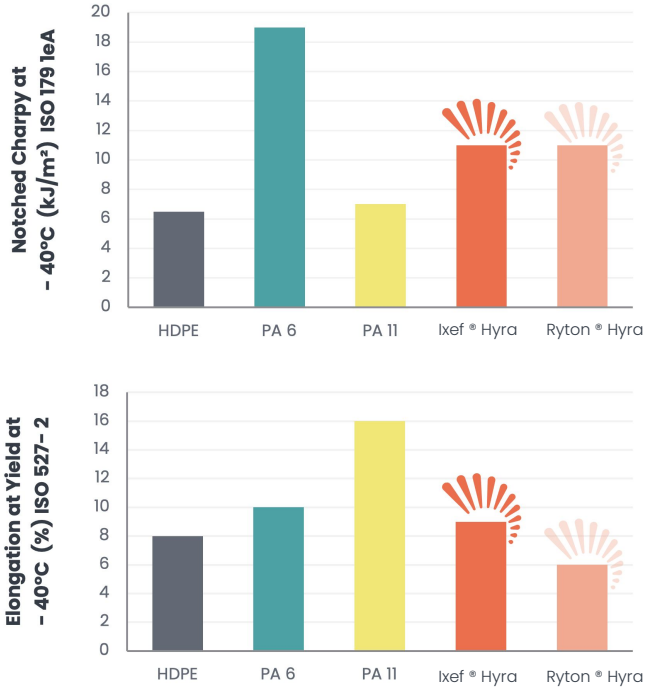
A Syensqo materials viable across a **wider temperature range**

Good balance of properties at low T versus incumbent

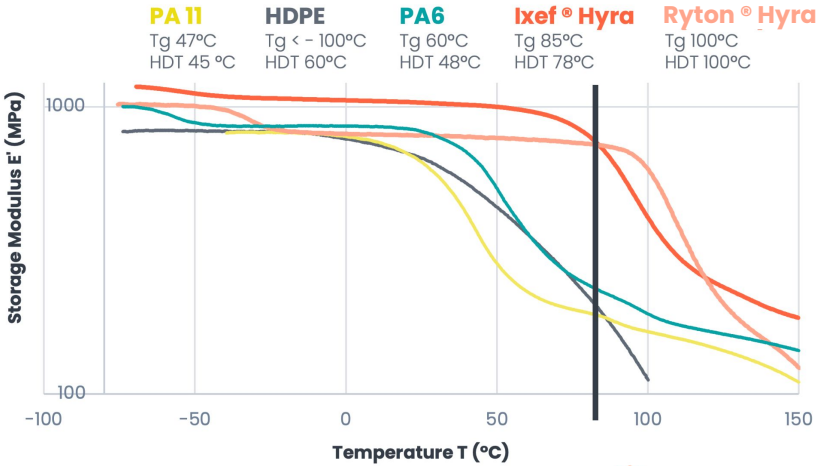
Significantly improved thermomechanical properties (stiffness)

No transition of Syensqo materials in T range of operation

LOW TEMPERATURE (-40°C)

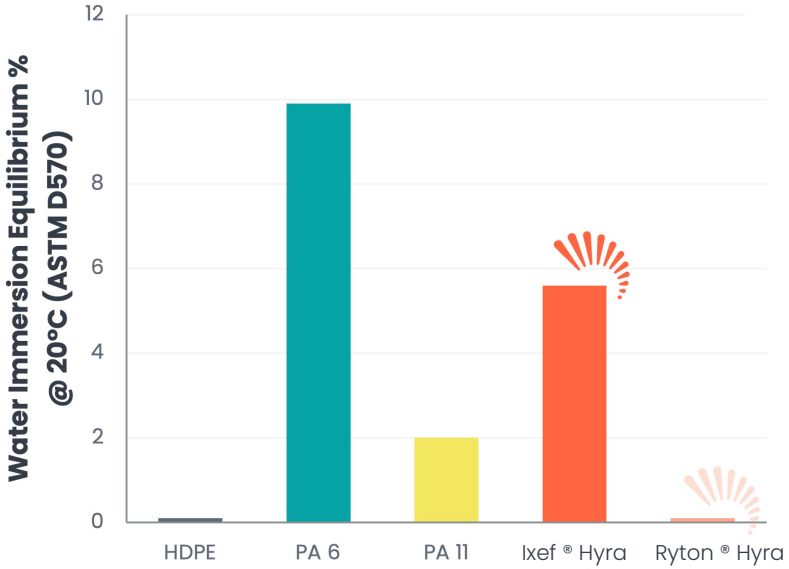


HIGH TEMPERATURE (>85°C)



SYENSQO

Syensqo materials with **low moisture absorption**



Ixef® Hyra has significantly lower moisture absorption versus PA 6
Ryton® Hyra has very low moisture absorption comparable to HDPE
→ **less H_2 contamination by moisture**
→ **better process consistency**

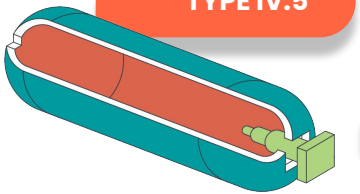
Difficult to decontaminate current tanks

Risk of liner collapse under partial vacuum

No / limited adhesion liner / composite

High cost for tank recertification (H_2 transportation)

TYPE IV.5

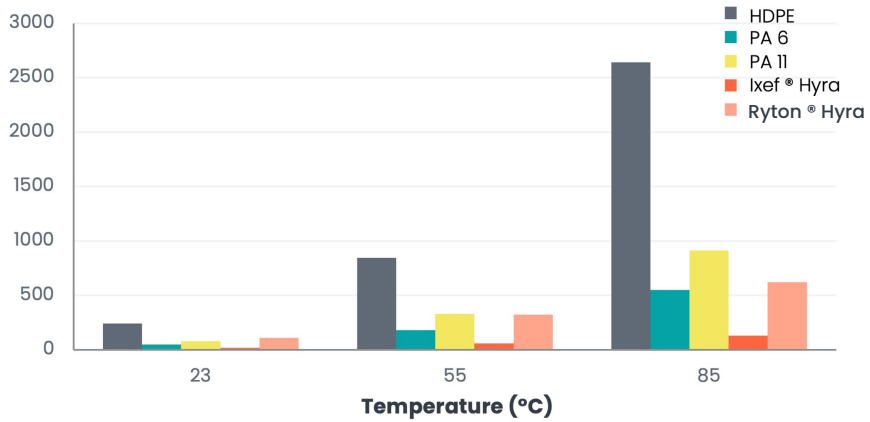


Tank type IV.5: similar polymer matrix for liner and composite creating a strong interface until End of Life

Syensqo works on leveraging resin formulation know how for thermoplastic composites

SYENSQO

Syensqo materials with **low permeability to H_2**



T° (°C)	H2 Permeability Coefficient (NccSTP.mm/m².d.b)				
	HDPE	PA 6	PA 11	Ixef® Hyra	Ryton® Hyra
23	240	47	79	17	110
55	846	181	330	58	324
85	2640	550	912	131	622

IXEF® HYRA

Ixef® Hyra has significantly lower H_2 permeation (> 3 x)

H_2 permeation increases significantly at T > T_g
→ **Ryton® Hyra** ≅ PA 6 and PA 11 at T > 55 °C

Measurements are done dry
Moisture depresses Tg of polyamides

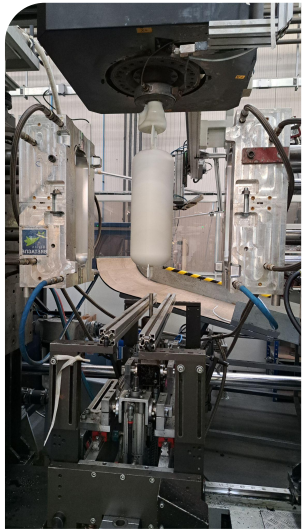
Ixef® Hyra passes stringent H_2 cycling test
250 cycles, 50 °C, **875 bar** / 50 bar, 170 bar/min

Ixef® Hyra passes rapid gas decompression
Saturate 168 h at **875 bar**, 20°C,
decompress in **< 5 sec**

→ **Ryton® Hyra** testing ongoing

SYENSQO

Syensqo materials enabling **thinner liners**



Easy and cost-effective manufacturing:
extrusion blow molding, extrusion, injection molding

IXEF® HYRA

Ixef® Hyra → good thickness distribution with wall thickness of 2 mm versus 4 mm PA 6

- → **Potential for thinner liners** (higher stiffness versus incumbent)
- → **Store more H_2 / less weight**
- → **Better carbon footprint of H_2 tanks**
- → **Higher freedom of tank designs**
  (e.g. longer tanks with smaller diameters, which need better barrier)

SYENSQO

In a nutshell
Syensqo & Hydrogen tanks

SYENSQO MATERIALS FOR LINERS

- **Extended temperature range** for fast tank filling (700 bar tanks) (less H_2 pre-cooling)
- **Less risk of contamination & reduced manufacturing variability** (due to lower H_2O absorption)
- **Low permeation** allowing design freedom
- **Thinner liners** with **lower CO_2 footprint**
- **Design efficiency**: e.g. conformable tanks, high L/D ratio

EXPLORE BEYOND

Syensqo working on leveraging resin formulation know how for thermoplastic composites targeting:

→ Tougher matrix (burst after fatigue)
→ Vacuum resistance (IV.5 tanks)
→ Less variability in processing & more design freedom (use less carbon fiber)
→ Potential for H_2 barrier
→ Recyclability

THANK YOU!

innoviris .brussels we fund your future
COMFHY
MAXIMATOR HYDROGEN France
Mecadi
cetim
AFPT
TESTNET by IA Solutions
ACTUA PLAST.
ST BlowMoulding
GHENT UNIVERSITY
SYENSQO

SPEAKER 7

ANDREA Rolfi
Customer Technical
Development Engineer
Green Hydrogen Platform

SYENSQO

QUESTION?

MATERIALS ENABLING HYDROGEN TECHNOLOGY

From **OUR LAB** into **a product.**

How can **SYENSQO** **support innovation** DRIVEN CUSTOMERS?

SYENSQO

Supporting our customers
in their advanced material solutions qualification journey

HIGH - PERFORMING

PRODUCT

RIGHT

PROCESS

BEST-IN-CLASS

PERFORMANCE

Syensqo Green Hydrogen PLATFORM'S AMBITION

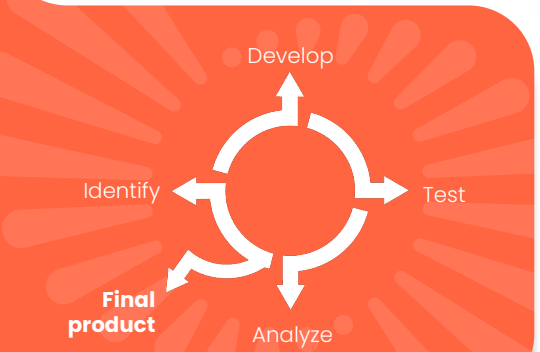
Develop and provide high-performing **products** that with the right **processing** are able to deliver best-in-class **performance** in their final application

SYENSQO

Supporting Customers Globally

Our International Footprint

Syensqo is able to leverage their years of diverse expertise, customizable **pilot manufacturing facilities** and state of the art **laboratory** infrastructure to best serve their customers with advanced material solutions

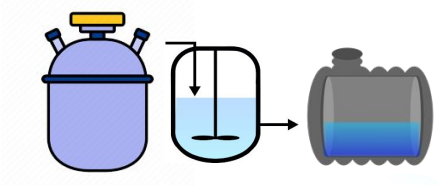


SYENSQO

Driving Excellence in Product, Process and Performance

PRODUCT

Pilot manufacturing facilities for product development, scaling-up, and industrialization.



PROCESS

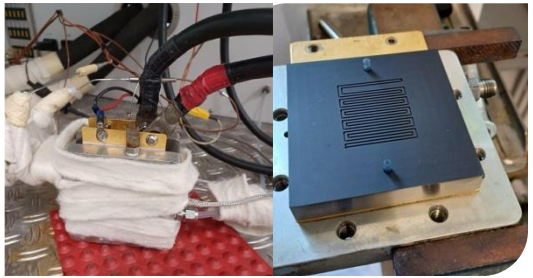
Processing our products enables us to help customers find the right processing parameters and to enable testing the performance of the materials after processing

Processing know-how and equipment range from molding and extrusion to membrane, electrode & separator preparation.

PERFORMANCE

Integrating our materials in real application environments enables testing the performance of the materials in the final application

Application know-how and equipment range from fuel cells to electrolyzers and redox-flow batteries.



SYENSQO

Characterization key enabler
for optimized products, processes & performances

Multi-technique approach to generate basic knowledge, leveraging standard methods & innovative customized approaches

Characterization capabilities examples:

- **Analytical & material characterization**: Physical test, mechanical & chemical resistance, spectroscopy, chromatography, inorganic analysis, morphology, rheology.
- **Electrochemical characterization**: Conductivity, gas permeability, aging test, polarization, EIS, etc.

SYENSQO

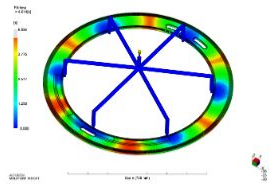
Design & Virtual Engineering key enabler

for optimized products, processes & performances

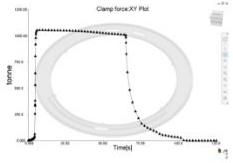
INJECTION MOLDING SIMULATION

(MOLDFLOW)

- Filling pattern weld lines ...

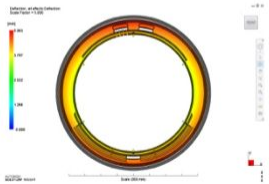


- Injection pressure and clamping force



- Volumetric Shrinkage

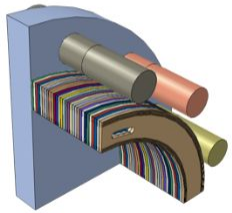
- Part Deflection

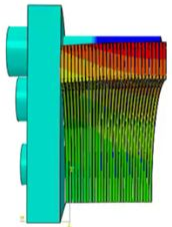


ADVANCED STRUCTURAL MODELS

(ABAQUS + DIGIMAT)

- Analysis of a partial stack of frames including:
  - → Axial Compression
  - → Thermal Expansion
  - → Internal Pressure
  - → Material anisotropy for fiber reinforced polymers
  - → Quasi-static / secondary creep properties





SYENSQO

SPEAKER 8

BRIGITTE Neubauer
Key Account Manager

SYENSQO

Q & A

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Thank YOU

Scan the QR code to download our brand new e-guide on **Advanced Material Solutions for Fuel Cell Electric Vehicles**

...and stay tuned! A **second e-guide focusing on electrolyzers** will be published on our website soon!

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