

# LARGE-SCALE HYDROGEN STORAGE SOLUTIONS TO OPTIMIZE H<sub>2</sub> PROJECTS

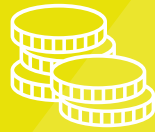
Hydrogen Tech World Expo + Conference, Essen  
June 2024

Vallourec® New Energies is Vallourec's commercial offer for the energy transition

# VALLOUREC: A GLOBAL LEADER IN HIGH-PERFORMANCE TUBULAR SOLUTIONS FOR THE ENERGY SECTOR



**15,000**  
employees



**€5.1bn**  
revenue



**Over 135**  
years of history  
and expertise

**€34m**  
spent on R&D



**UNDISPUTED  
CUTTING-EDGE  
CAPABILITIES**  
in steelmaking,  
rolling, heat treatment  
and threading



**+1.5m**  
**tonnes**  
of tubes shipped



# DEVELOPMENT OF GREEN H<sub>2</sub> TRIGGERS LARGE STORAGE NEEDS

A crucial lever for cost optimization  
and security of supply



Cope with **intermittency** of renewables  
Optimize **electricity price** and H<sub>2</sub> cost



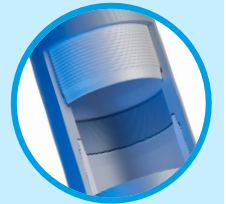
Support **smooth logistics**



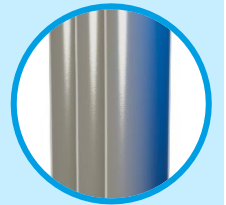
Ensure **continuity of supply**  
to H<sub>2</sub> offtakers

Combine grid-scale solutions  
and on-site storage

Geological storage for large-scale  
and grid connected storage  
**Salt caverns, depleted fields**



Smaller storages needed  
when/where not connected to grid  
**Cylinders, vertical storage**



**NEW STORAGE NEEDS, REQUIRING NEW SOLUTIONS**



# BUT LARGE-SCALE H<sub>2</sub> STORAGE IS CHALLENGING



SAFETY IS KEY

THERE IS LIMITED  
SPACE AVAILABLE

AND ACQUIRING PERMITS  
IS CHALLENGING

# INTRODUCING VALLOUREC'S VERTICAL STORAGE

- ▶ **Compressed hydrogen stored in pipe assemblies**

Leveraging Vallourec's core products and expertise

- ▶ Vertical subsurface designs up to  
**100 meters / 330 ft deep**

- ▶ Wide capacity range  
**1 to 100 metric tons of H<sub>2</sub>**

- ▶ Available at high pressures  
**up to 500 bar / 7,500 psi**  
200-350 bar expected optimum for most projects





# KEY FEATURES: SMALL FOOTPRINT, SAFE & PROVEN COMPONENTS

 **SAFETY  
IS A PREREQUISITE**

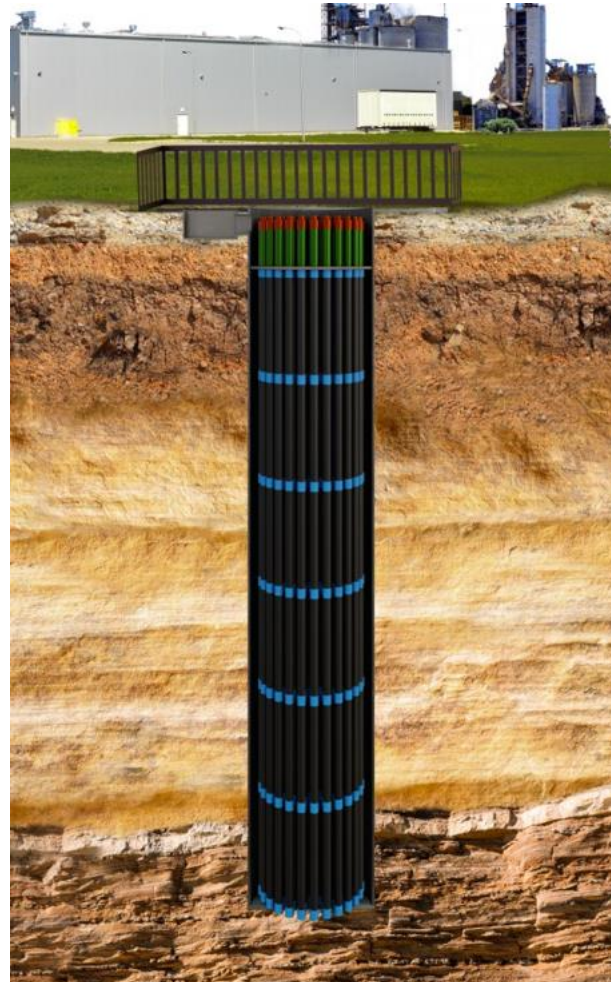
 **VOICE OF CUSTOMER**

## QUESTION

On a 1-10 scale, how important  
is Safety in your project evaluation?

## ANSWER

*"For us it's 12 out of 10!"*



**SAFETY**

Proven  
hydrogen-resistant  
alloys & hydrogen-  
tight connections

Safety from  
subsurface storage



**PROJECT  
PERMITTING  
& PROJECT  
SCHEDULE**

Underground,  
'invisible' storage,  
minimal set-back  
distances facilitate  
project approvals  
& public  
consultations



**FLEXIBILITY  
& MODULARITY**

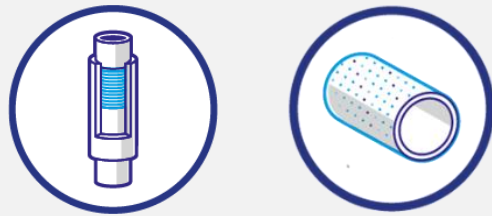
Vallourec modular  
H<sub>2</sub> storage is split  
into several strings  
& uses H<sub>2</sub>-tight  
connectors and caps,  
allowing for easy  
storage capacity  
additions

# SUPERIOR SAFETY PROFILE

## Based on proven components

- ▶ Benefits from long track record and R&D program
- ▶ Tested per relevant standards

**Steel materials  
optimized for H<sub>2</sub>**



**H<sub>2</sub>-tight connections**

## Thorough risk analysis and qualification program

- ▶ Working with recognized **third-party expert** DNV
- ▶ Qualification process according to Recommended Practice DNV-RP-A203 (Qualification of New Technology)
  - **Statement of Feasibility**
- ▶ **Demonstrator** in service, supporting full test program
- ▶ Ongoing approval process according to **pressure equipment regulations**

## Vertical subsurface design to minimize hazards

- ▶ Architecture of the systems minimizes overall risk and setback distances

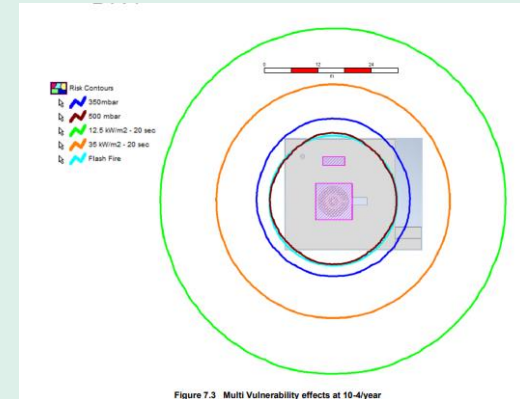


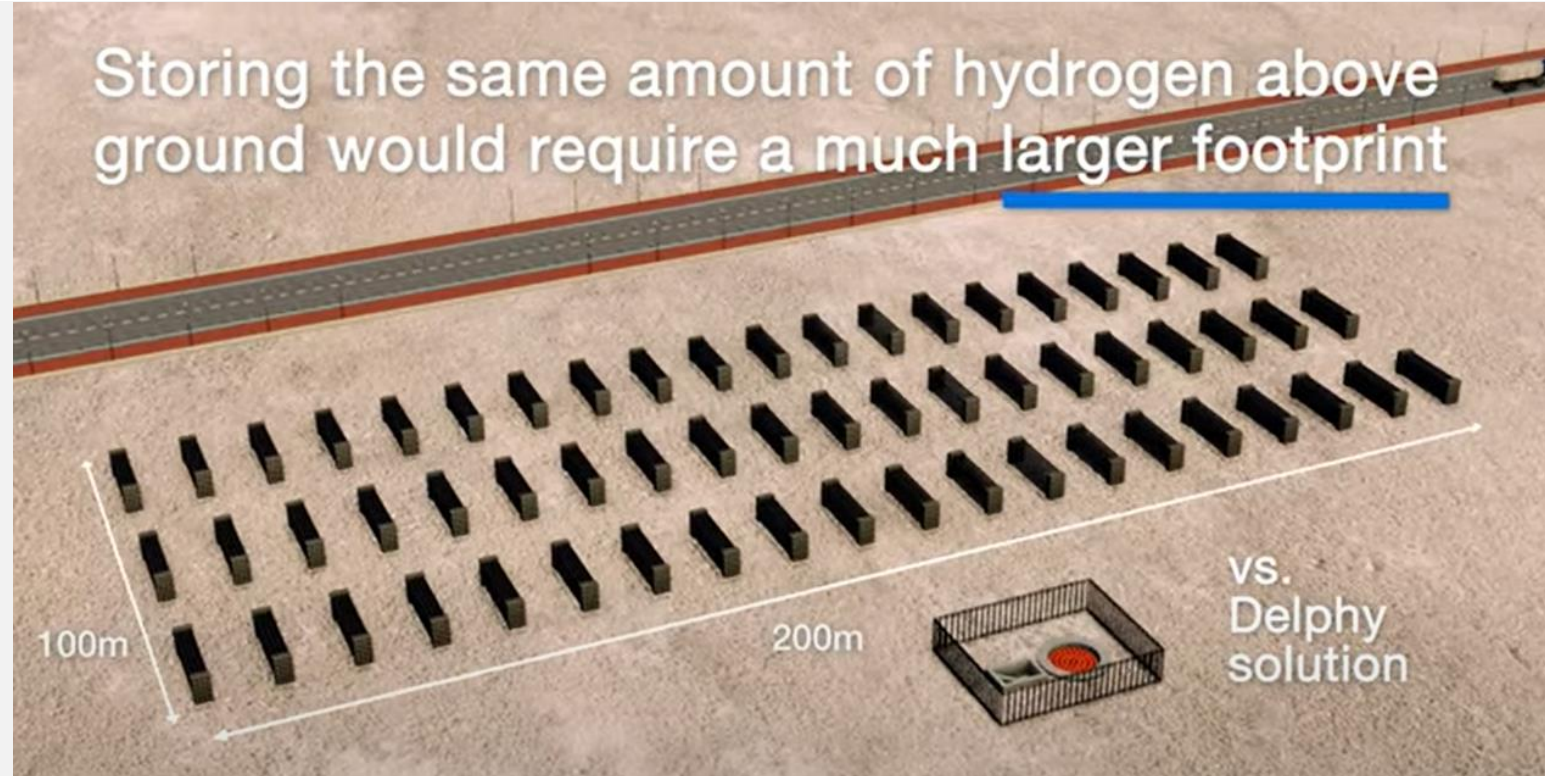
Figure 7.3 Multi-vulnerability effects at 10-4/year

*Illustrative multi-vulnerability effects for 10 t H<sub>2</sub> storage (DNV modelling)*

**Much reduced vs. basic above-ground options**

**KEY FOCUS ON SAFETY, INTEGRITY AND LONGEVITY OF H<sub>2</sub> STORAGE**

# MUCH NARROWER FOOTPRINT THAN ABOVE GROUND



At least **30 times** more compact  
than above-ground options

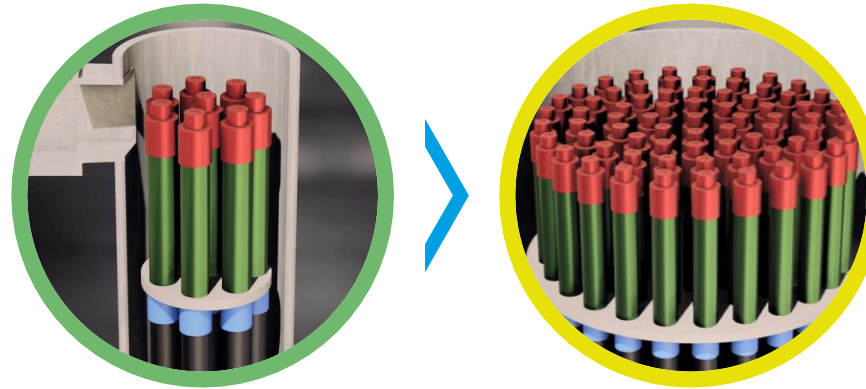
Eases site integration, permitting  
and acceptance, cost optimization



# FLEXIBLE & MODULAR, TO ADAPT TO YOUR PROJECT

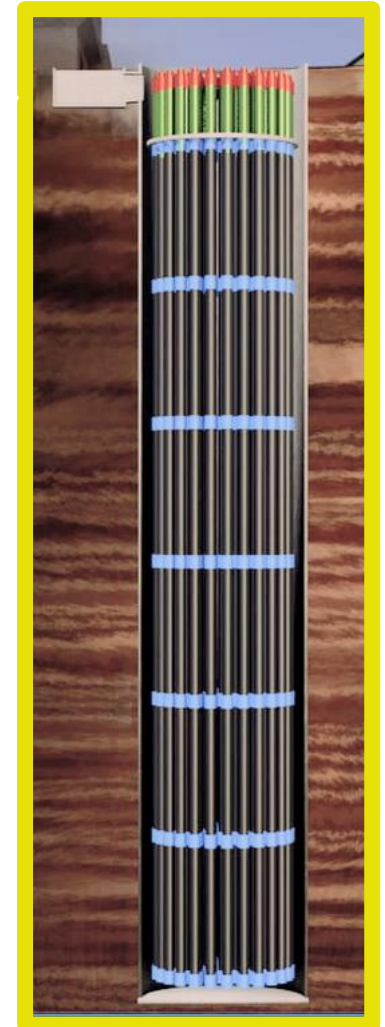
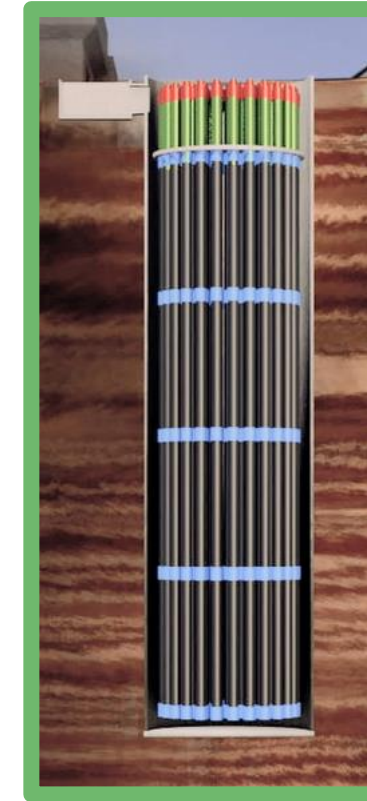
► **Many parameters can be customized and optimized depending on specific cases, e.g.**

- Storage capacity
- Pressure level(s)
- Width and depth



► **Modularity, to adapt to project evolution**  
(e.g., phases)

► **Operating flexibility with different pressure groups**



# FULLY-FUNCTIONAL DEMONSTRATOR BUILT WIDE RANGE OF VALIDATION TESTS ONGOING



**Fully designed and  
built on Vallourec's  
site in Aulnoye**



**System pressurized in  
November – start of tests**

**Demonstrator inaugurated  
in December 2023**



**TURN-KEY IMPLEMENTATION WITH ALL DESIGN, MANUFACTURING, AND CONSTRUCTION STEPS**



# COMPREHENSIVE TECHNOLOGY QUALIFICATION PROGRAM FOR BEST SAFETY

## Technology qualification with support of recognized experts

- ▶ Risk reviews (FMECA, HAZID, HAZOP, QRA)
- ▶ Technology Qualification Plan
- ▶ Regulatory Approval process



## Full test program on the demonstrator



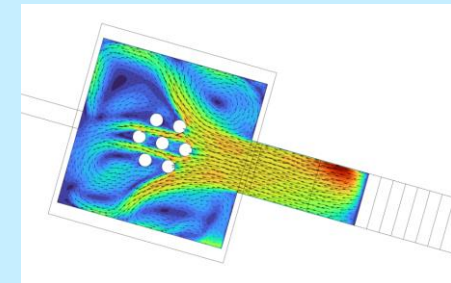
Set-up for hydrotest

- ▶ Tightness tests, pressure cycles
- ▶ Hydrotest
- ▶ Ventilation, water management
- ▶ NDT inspection
- ▶ Emergency scenarios



## Supported by all R&D know-how

- ▶ Material testing (fracture toughness, fatigue)
- ▶ Component testing (pressure cycling)
- ▶ Simulation (ventilation, hazards)



Simulation of air renewal in the upper cavity



# GETTING READY FOR INDUSTRIAL SCALE

## ► Customers are expressing solid interest

*“This is exactly what we need for our ammonia production project. We’ve been looking for a solution like this.”*

*“When looking at our e-SAF projects, we were concerned that no storage solution would exist at the needed scale, but now we see it with Delphy.”*

*“We believe this design is a great fit for our H<sub>2</sub> assets. We see great demand in the future for this system and would like to be the first company in [our region] to utilize Delphy.”*

*“Having a large hydrogen storage capacity is a differentiator for our projects: it allows us to produce hydrogen when the green electricity is available and sell green hydrogen at a later time, at a premium.”*

## ► First partnerships announced

### H2V Partnership 31 Jan 2024

To integrate Delphy to H2V’s green hydrogen projects



### NEXTCHEM Partnership 3 April 2024

For industrial use of hydrogen such as the manufacture of green ammonia applications

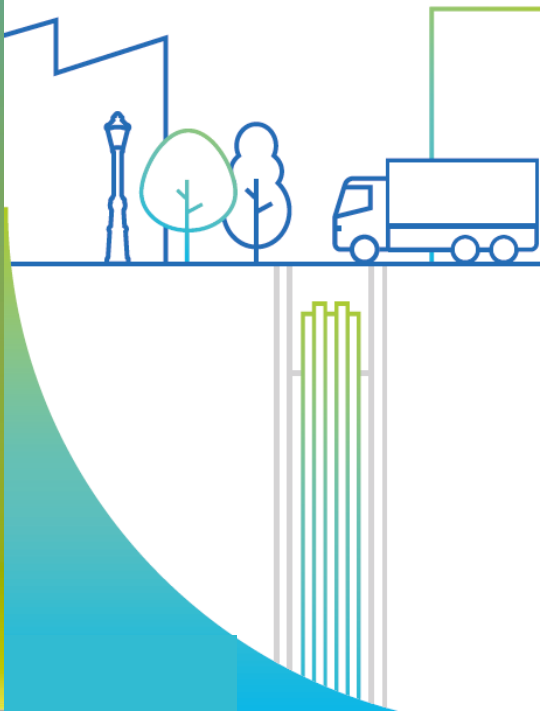


HOW ABOUT YOUR NEXT PROJECT(S)?

# A UNIQUE SOLUTION, ENABLING AND OPTIMIZING HYDROGEN PROJECTS



THE HYDROGEN  
STORAGE SYSTEM  
OF TOMORROW.



Green H<sub>2</sub> comes with **high storage needs** for continuity of supply & cost optimization

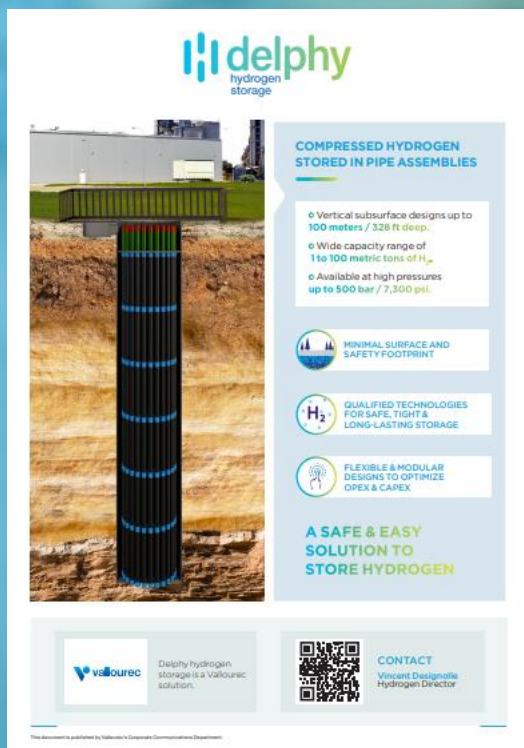
Vallourec brings a **unique solution** to **enable** large-scale hydrogen storage and unlock projects

Unique features and benefits:

- ▶ Designed for **high safety**
- ▶ **Minimal footprint** to ease with site lay-out & permitting
- ▶ Flexible & **modular** design

SMALL FOOTPRINT.  
BIG IMPACT.  
THIS IS DELPHY.





# THANK YOU!

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Want to know more about Delphy hydrogen storage?  
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