



INNOVATIVE STORAGE SOLUTIONS FOR SEAMLESS INTEGRATION IN INDUSTRY & MOBILITY PROJECTS

November 2023

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

A TRUSTWORTHY PARTNER FOR CUTTING EDGE STEEL
SOLUTIONS THAT MAKE ENERGY TRANSFORMATION POSSIBLE



“Mission critical supplier of complex tubular solutions supported by industry-lead R&D and world-class production facilities.”



WE MAKE
LARGE-SCALE
HYDROGEN
STORAGE
POSSIBLE

DEVELOPMENT OF GREEN H₂ TRIGGERS LARGE STORAGE NEEDS

A crucial lever for cost optimization
and security of supply



Cope with **intermittency** of renewables
Optimize **electricity price** and H₂ cost



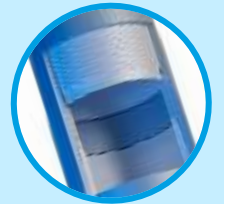
Support **smooth logistics**



Ensure **continuity of supply**
to H₂ offtakers

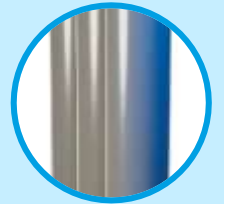
Combine grid-scale solutions
and on-site storage

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 H₂ STORAGE IS CHALLENGING



SAFETY IS KEY

BUT 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 H₂

- ▶ 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



PROJECT PERMITTING & PROJECT SCHEDULE



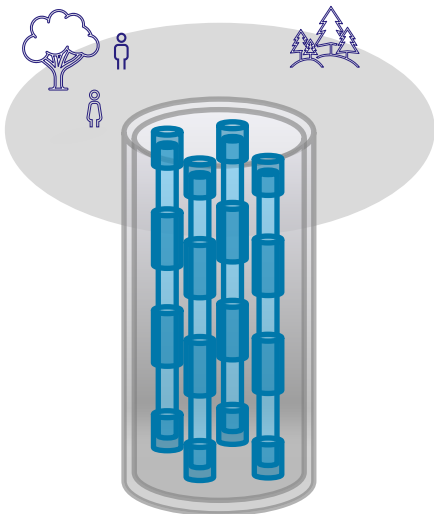
CAPEX / OPEX / TCO



FLEXIBILITY & MODULARITY



CO₂ FOOTPRINT



Proven hydrogen-resistant alloys & hydrogen-tight connections

Safety from subsurface storage

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

Vertical strings more cost efficient than a large number of smaller cylinders
Inspection & repairs possible thanks to connections

Vallourec modular H₂ storage is split into several strings & uses H₂-tight connectors and caps, allowing for easy storage capacity additions

Vallourec CO₂ credentials are ‘best-in-class’.

SUPERIOR SAFETY PROFILE

Based on proven components

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

Steel materials optimized for H₂



H₂-tight connections

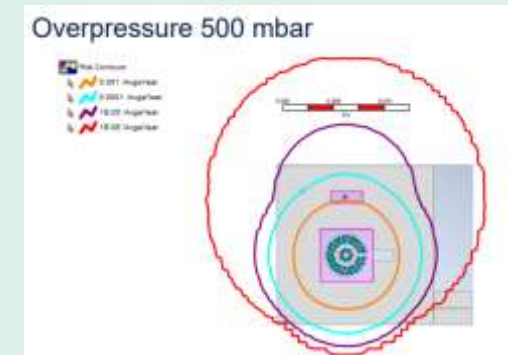
Thorough risk analysis and qualification program

- ▶ Working with recognized **third-party expert** DNV
- ▶ Qualification process according to Recommended Practice DNV-RP-A203 (Qualification of New Technology)
 - **Statement of Feasibility**
- ▶ Ongoing demonstration with **Proof of Concept** in construction



Vertical subsurface design to minimize hazards

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

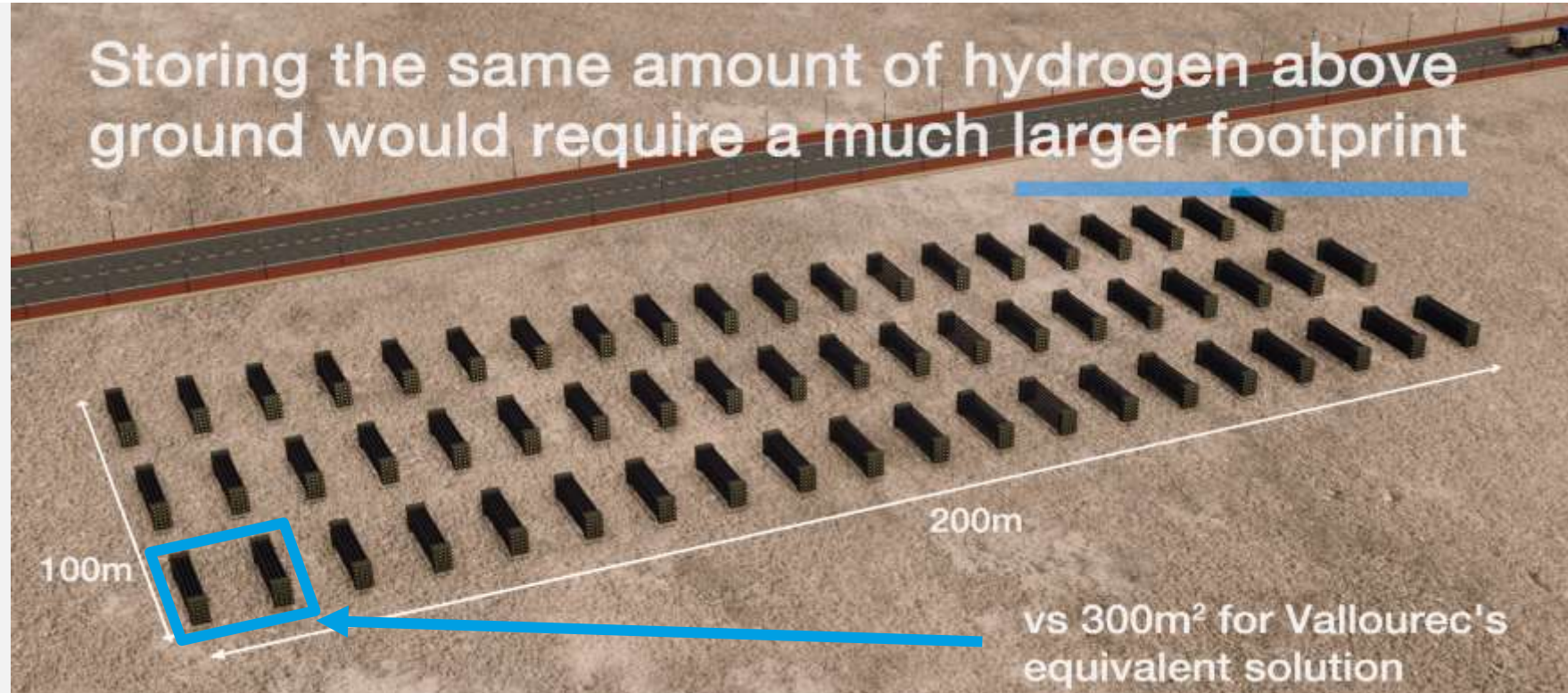


Illustrative risk contours for 10 t H₂ storage (DNV modelling)

Much reduced vs. basic above-ground options

KEY FOCUS ON SAFETY, INTEGRITY AND LONGEVITY OF H₂ STORAGE

MUCH NARROWER FOOTPRINT THAN ABOVE GROUND

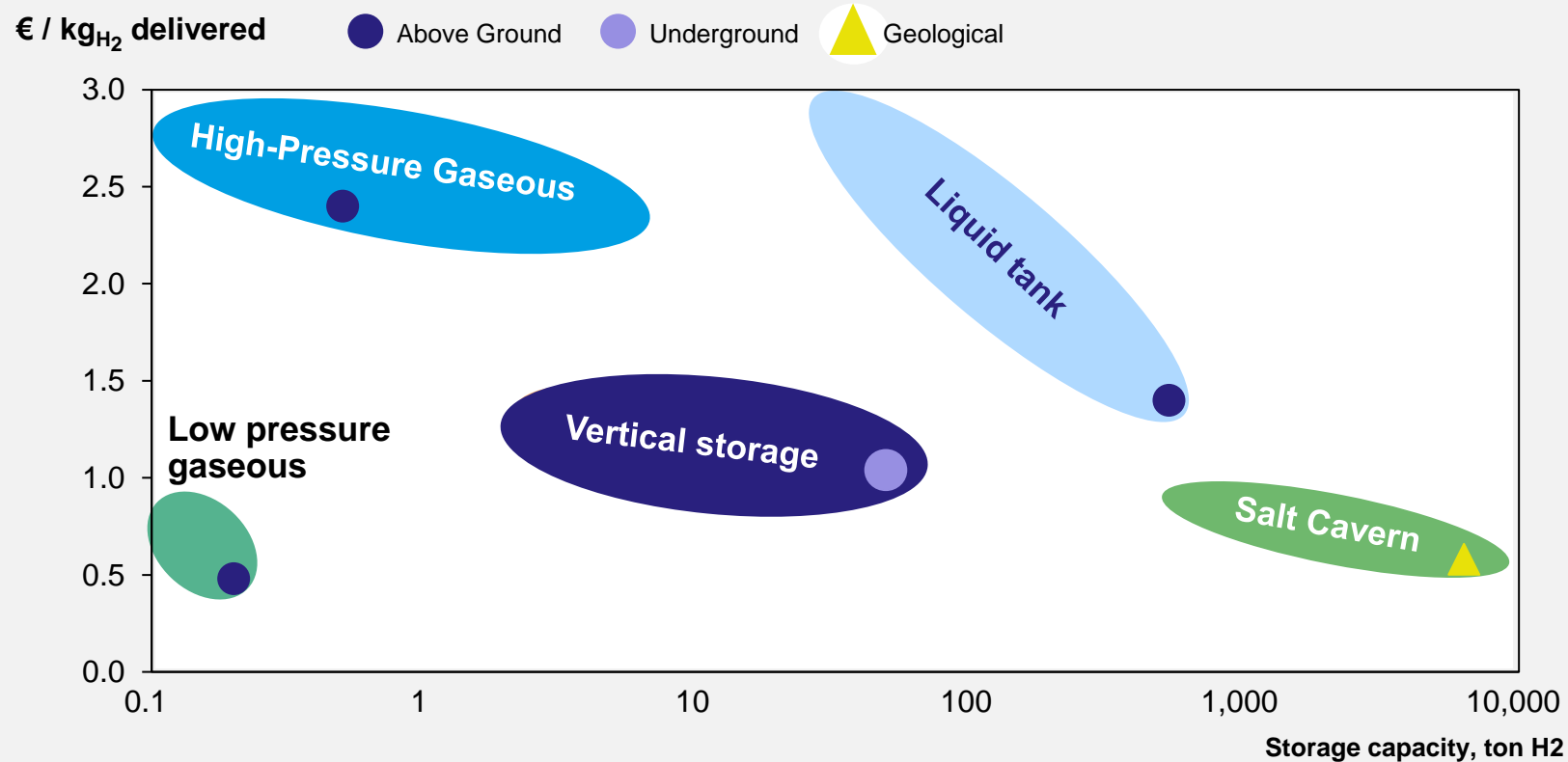


At least **30 times** more compact than above-ground options

Eases site integration, permitting and acceptance, cost optimization

A UNIQUE AND COST-EFFECTIVE SOLUTION FOR MID-SCALE STORAGE OF HYDROGEN

Matrix of hydrogen storage solutions



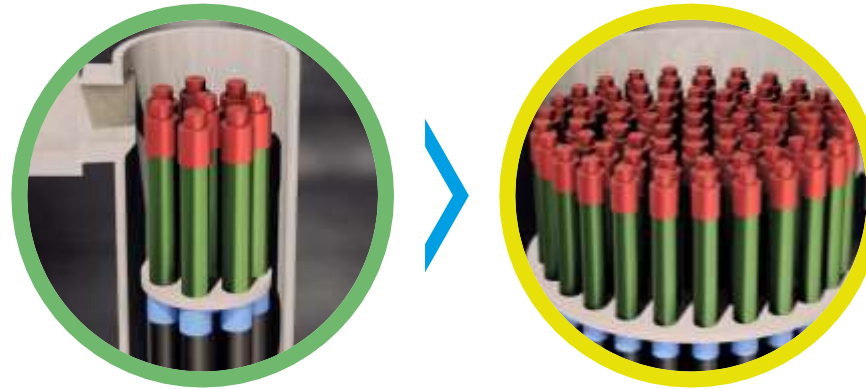
Source: Vallourec / IAC Partners, 2023

Solution cost is a per kg_{H2} delivered, model includes CAPEX & OPEX for the H₂ treatment plant & storage but does not include H₂ production cost

FLEXIBLE & MODULAR, TO ADAPT TO YOUR PROJECT

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

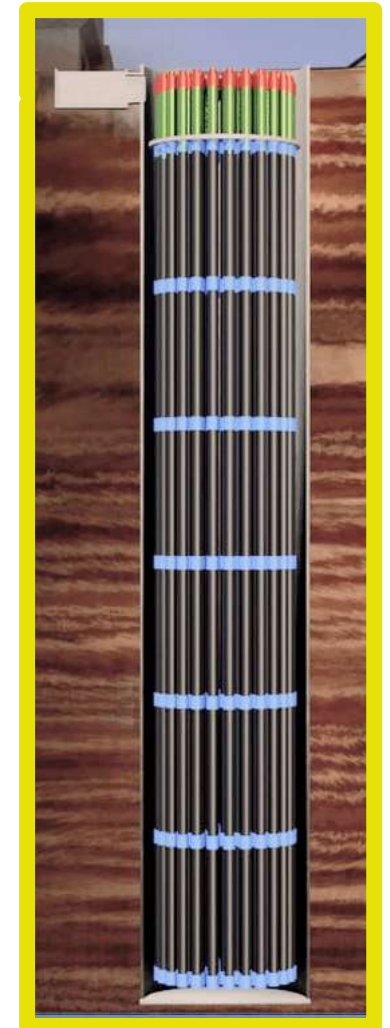
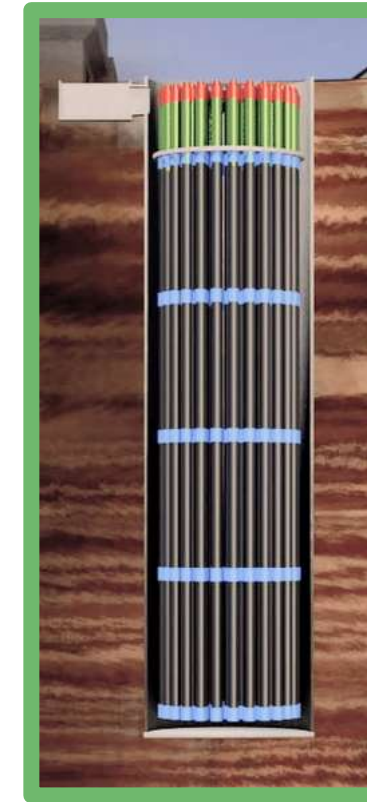
- Storage capacity
- Pressure level(s)
- Width and depth



► **Modularity, to adapt to project evolution**

(e.g., phases)

► **Operating flexibility with different pressure groups**



THIS IS ALREADY HAPPENING! PROOF-OF-CONCEPT IN CONSTRUCTION IN FRANCE

Drilling and
excavation



Civil works and
upper cavity
construction



Pipes and
end caps



Installation and
commissioning

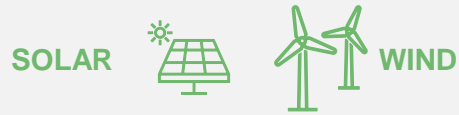


POC CONSTRUCTION IS ADVANCING STEADILY – FIRST TESTS IN NOVEMBER 2023

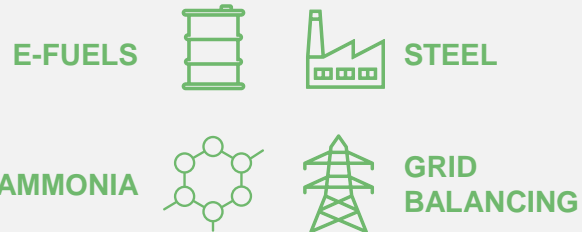
A UNIQUE SOLUTION, ENABLING AND OPTIMIZING HYDROGEN PROJECTS

Green H₂ comes with **high storage needs** for continuity of supply & cost optimization

- ▶ Intermittent power source



- ▶ Continuous H₂ offtake requirements



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

- ▶ **1-100 tons H₂**
5-50t H₂ 'sweet spot'
- ▶ **200-350 bar** pressure
Can be higher if required, e.g. mobility applications
- ▶ **20-100 m** depth
Within civil engineering domain



Unique features and benefits

- ▶ Designed for **High safety**
- ▶ **Minimal footprint** to ease with site lay-out & permitting

- ▶ Based on proven materials and connections for safety and longevity
- ▶ Minimal surface footprint, to ease site lay-out, safety, permitting, acceptance
- ▶ Flexible and modular, based on standardized components
- ▶ Cost efficient



THANK YOU!
VISIT US AT BOOTH D15



Contact:
Vincent Designolle
Hydrogen Director
vincent.designolle@vallourec.com

Want to know more about Hydrogen solutions? Download our solutions paper on solutions.vallourec.com

