

The HyCavern project

Unlocking the hydrogen economy through lined rock cavern storage

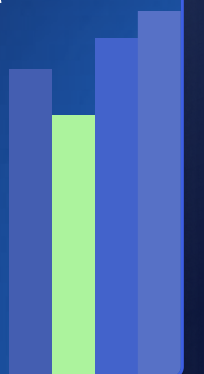
Underground hydrogen storage

Stores hydrogen in mined, lined rock caverns deep underground.



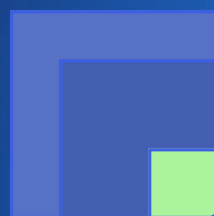
Lined rock cavern (LRC) concept

Combines steel and concrete lining with the surrounding rock mass to manage pressure.



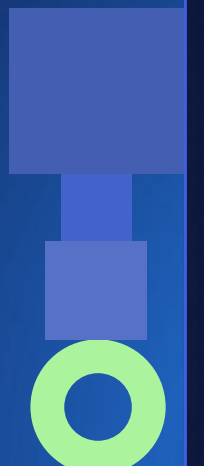
Scalable and replicable

Designed to be economically viable and repeatable across multiple sites.



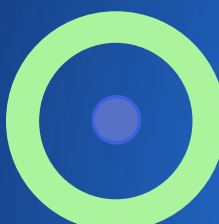
Geologically adaptable

Applicable across different rock types and locations in Europe.



Advanced materials

Uses innovative coatings, concrete, and sliding layers to enhance durability.



Built-in safety monitoring

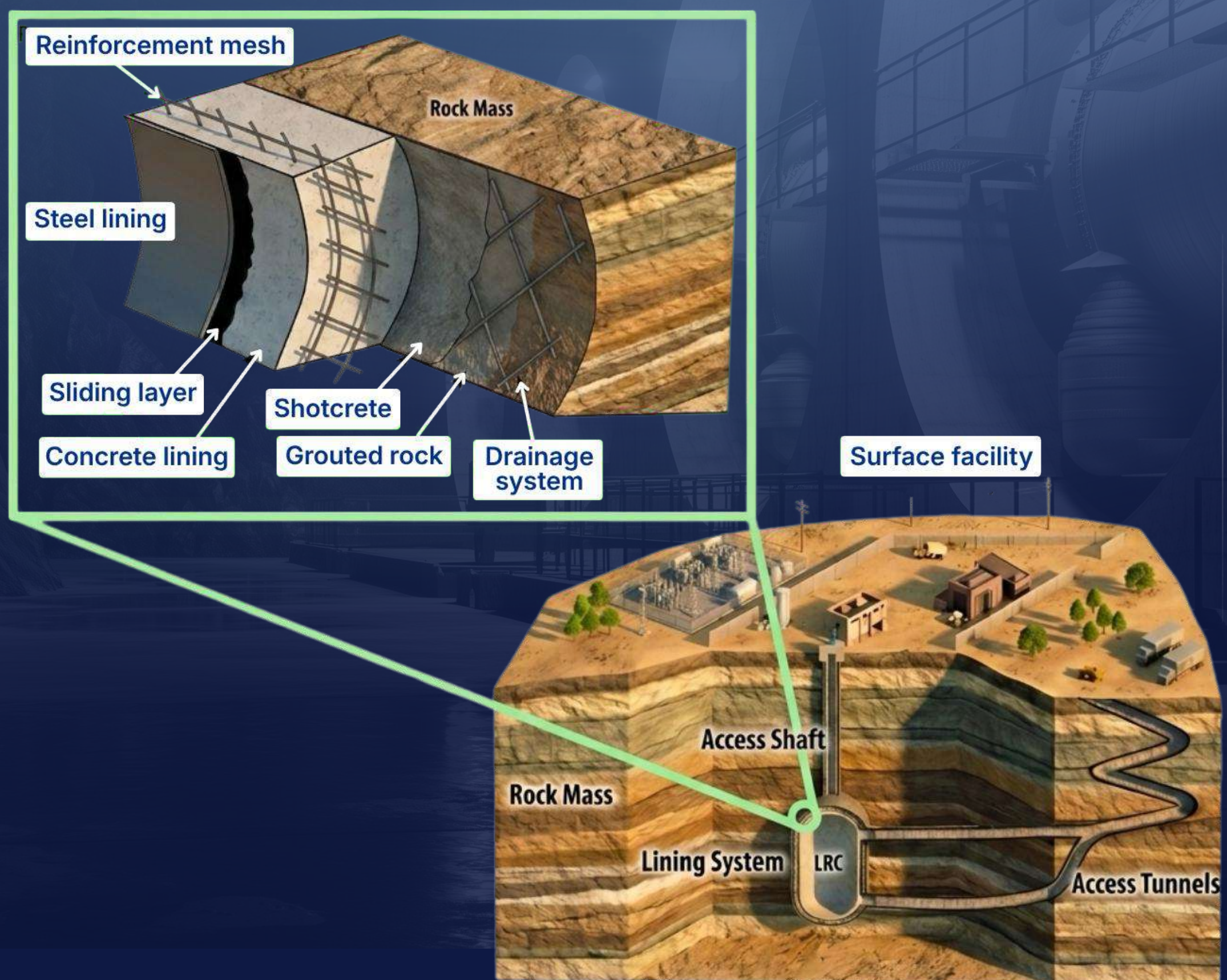
Integrates sensors and monitoring systems for long-term safety control.



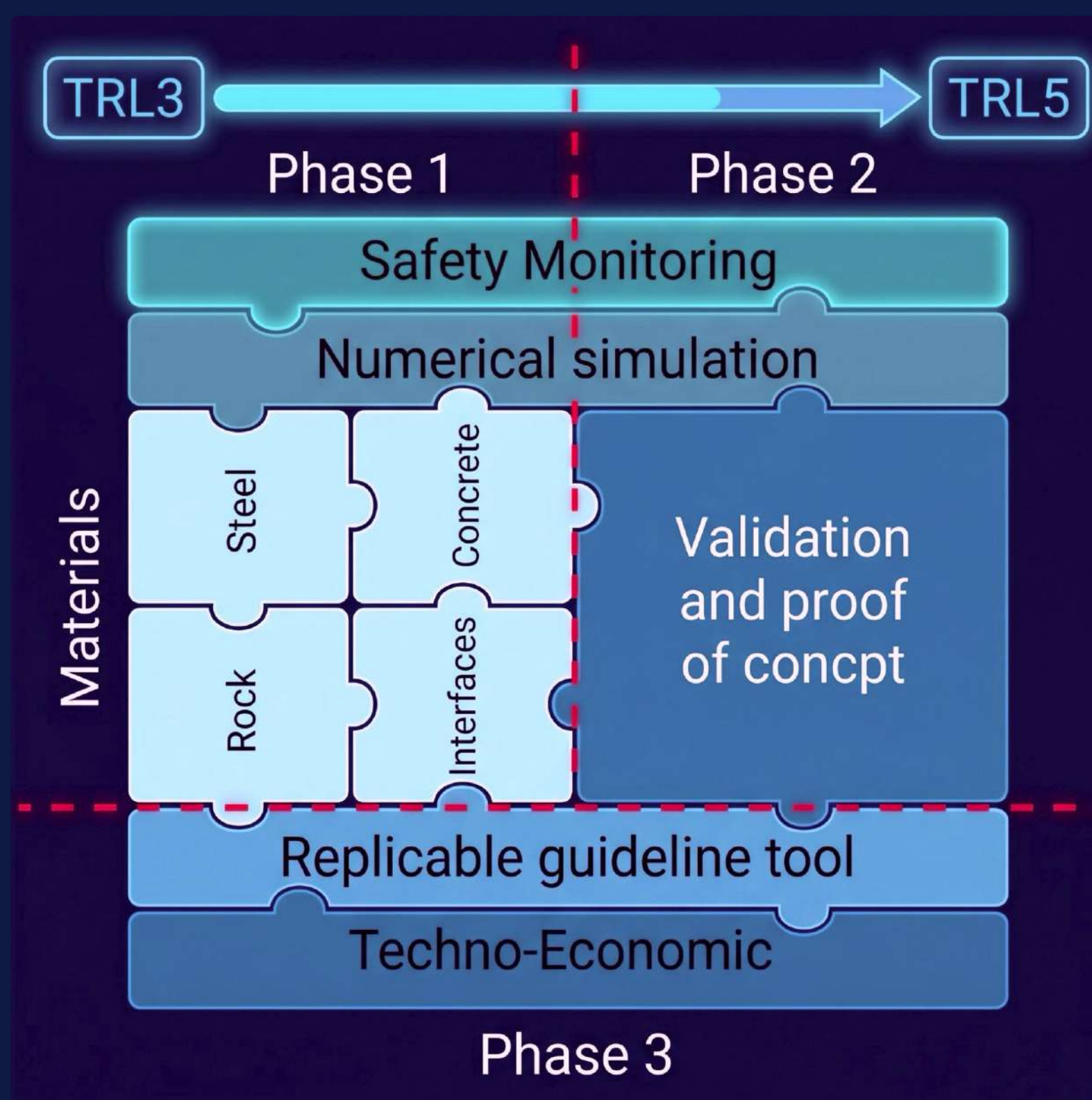
Project partners and advisory board



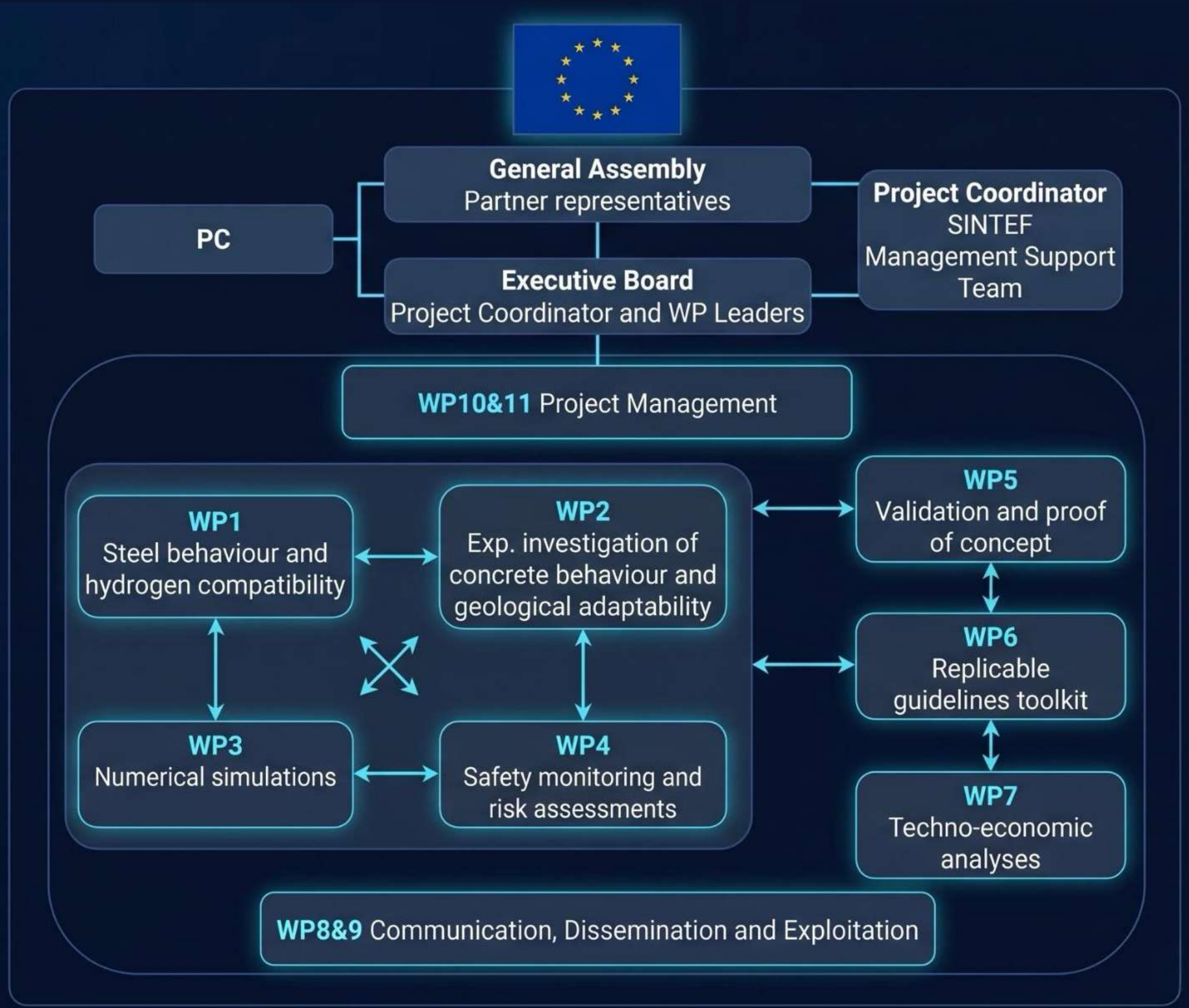
Linen rock cavern (LRC) concept



Project is organized in 3 phases



Structure of project & work package organisation



Objectives of HyCavern



Enable safe, cost-effective, and large-scale deployment of LRCs for H₂ storage across Europe



Address technical challenges in material behavior, geological adaptability



Contribute to European leadership for large-scale H₂ storage solutions



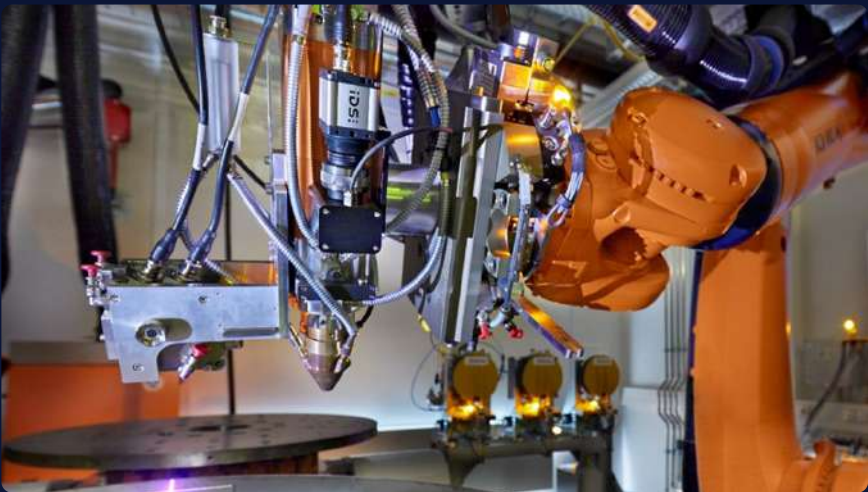
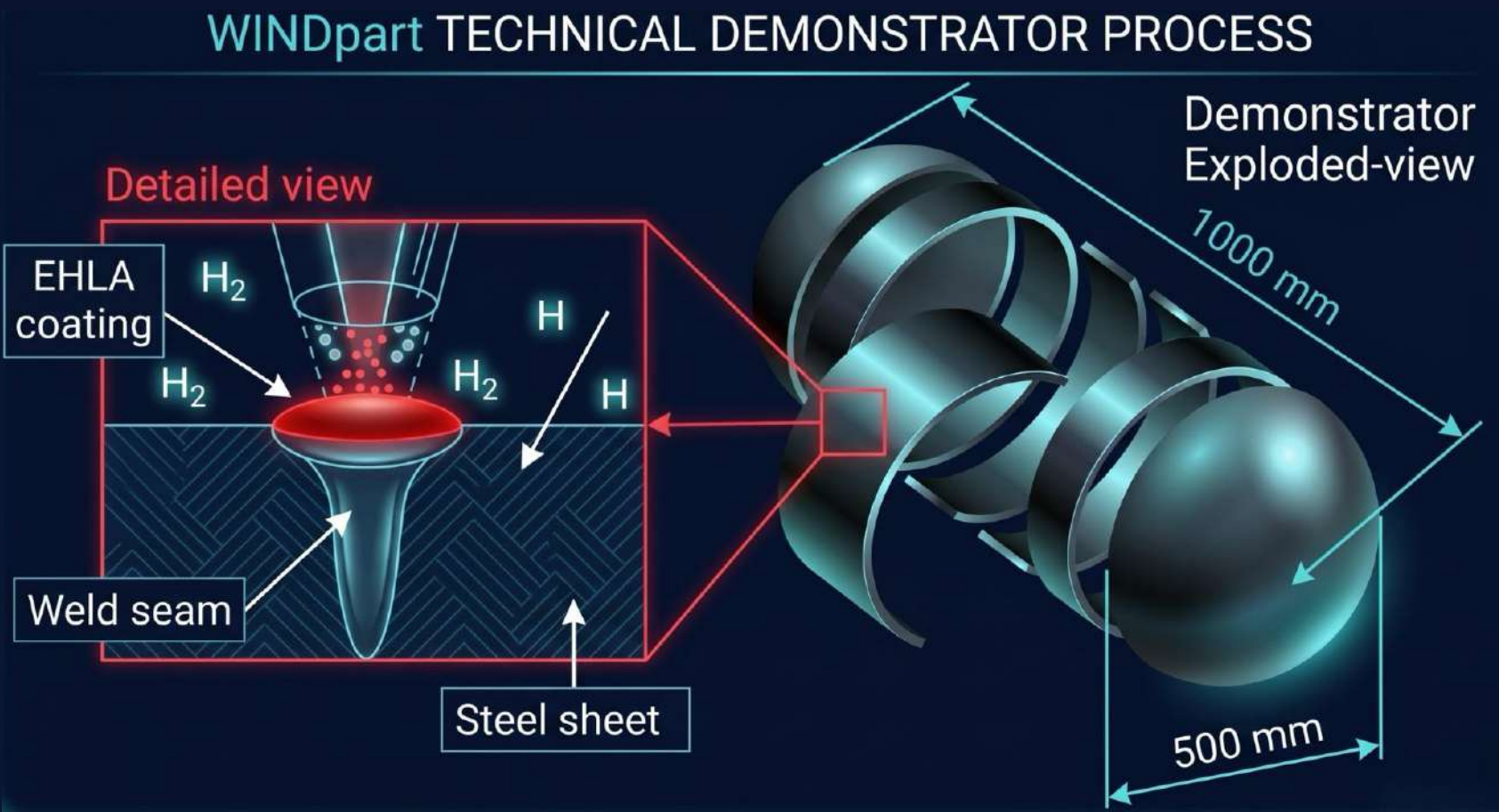
Revitalize underutilized cavern infrastructure



Support the EU's decarbonization goals by creating a fit-for-purpose H₂ storage

WP1 Steel behavior (FILT)

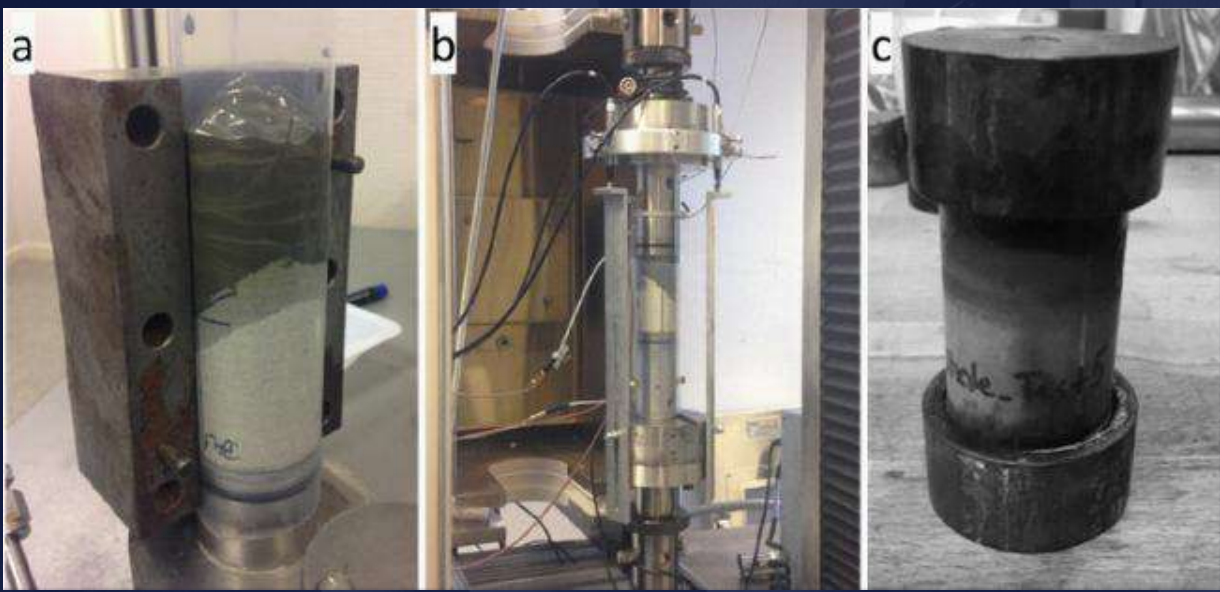
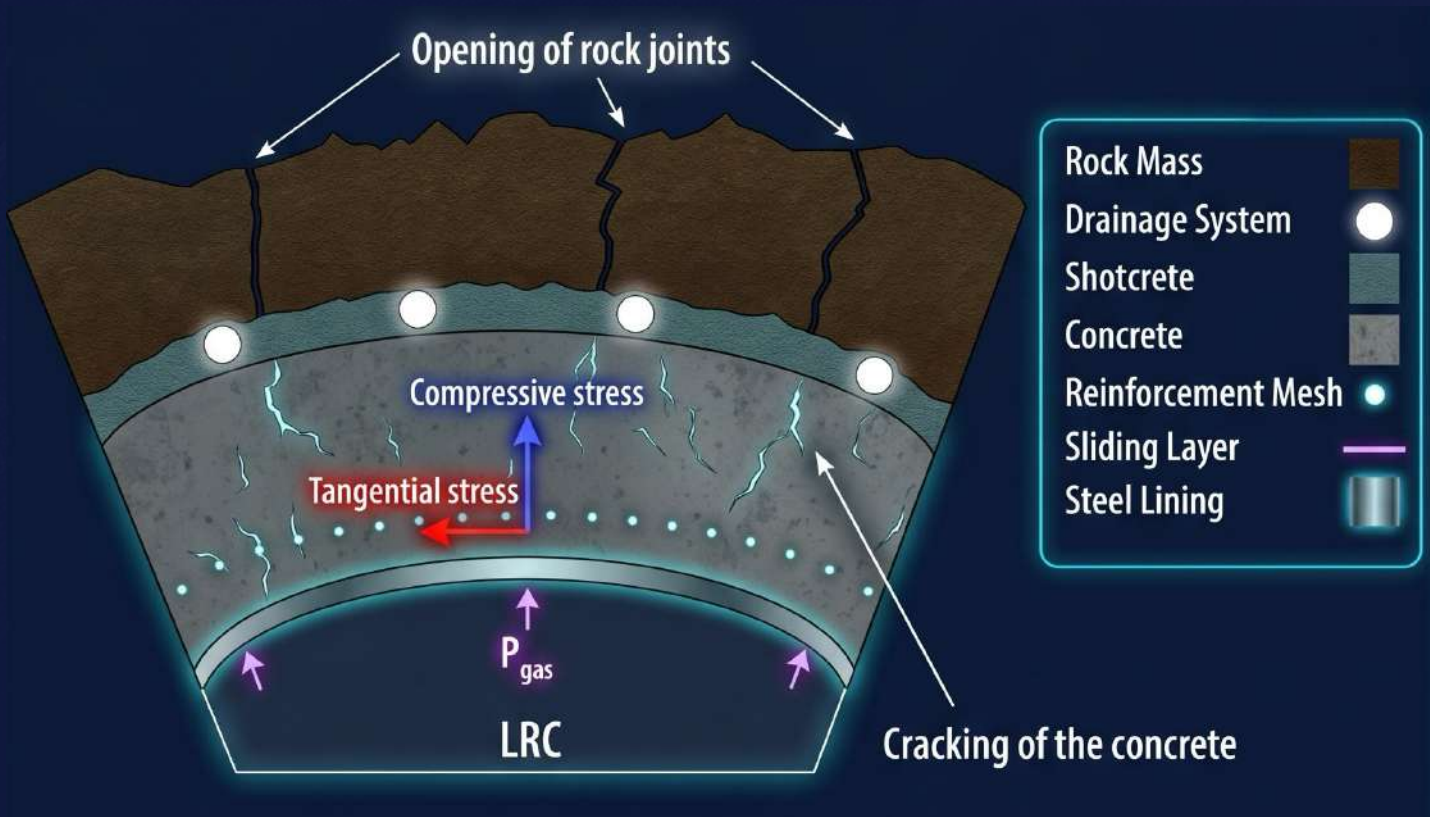
Develop and validate fully automated, laser-based manufacturing and coating process for LRC steel liners with enhanced hydrogen embrittlement and fatigue resistance



WP2 Concrete and rock behavior (UEDIN)

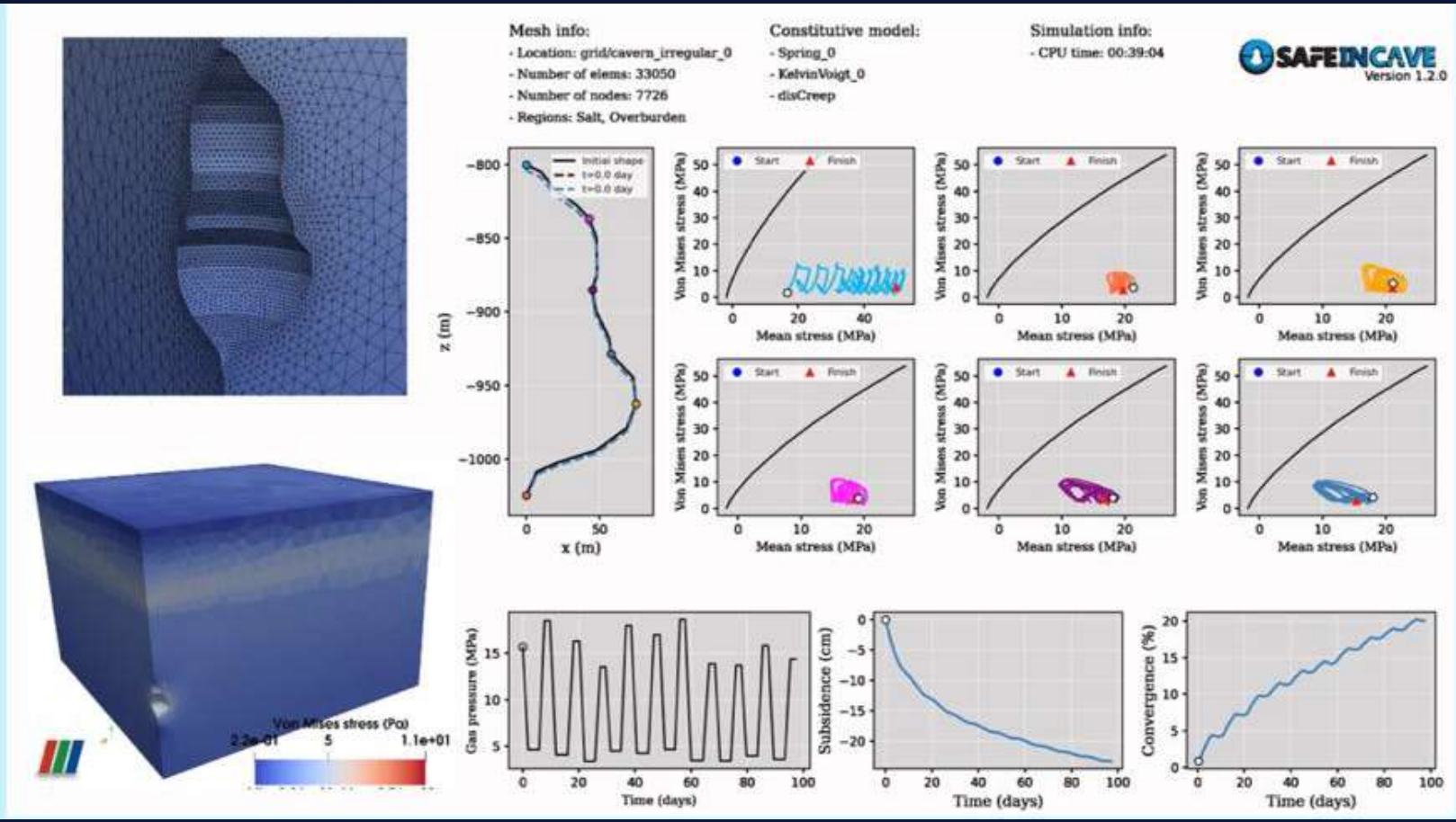
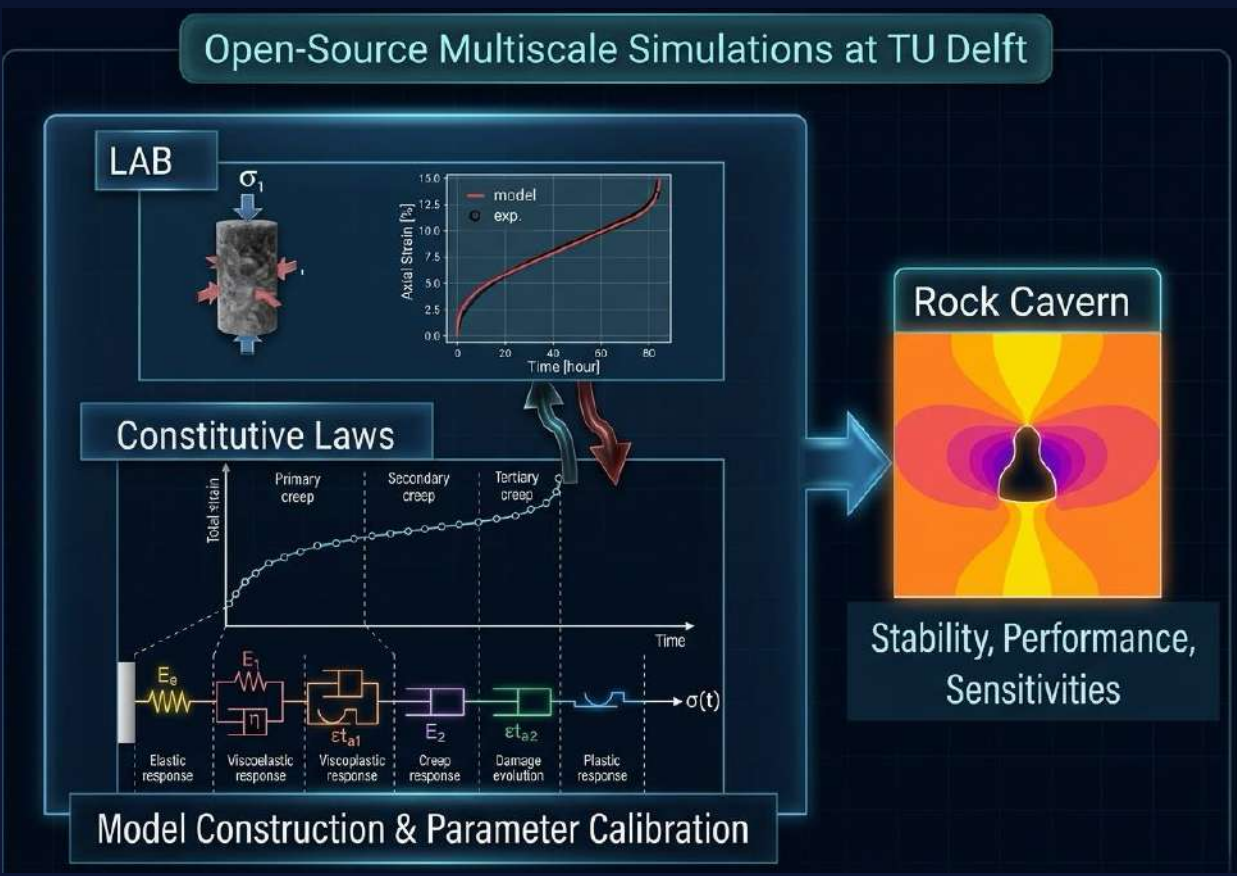
Assess low-carbon concrete and interface materials for LRCs wrt long-term mechanical and chemical stability under hydrogen and cyclic loading

Analyse how varying lithologies influence LRC feasibility and performance



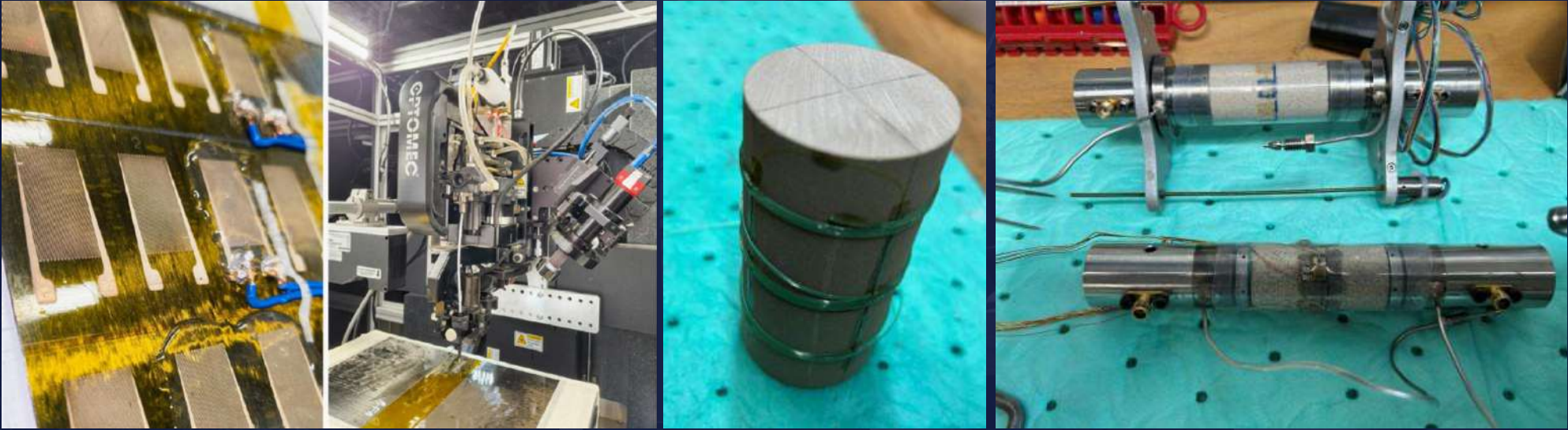
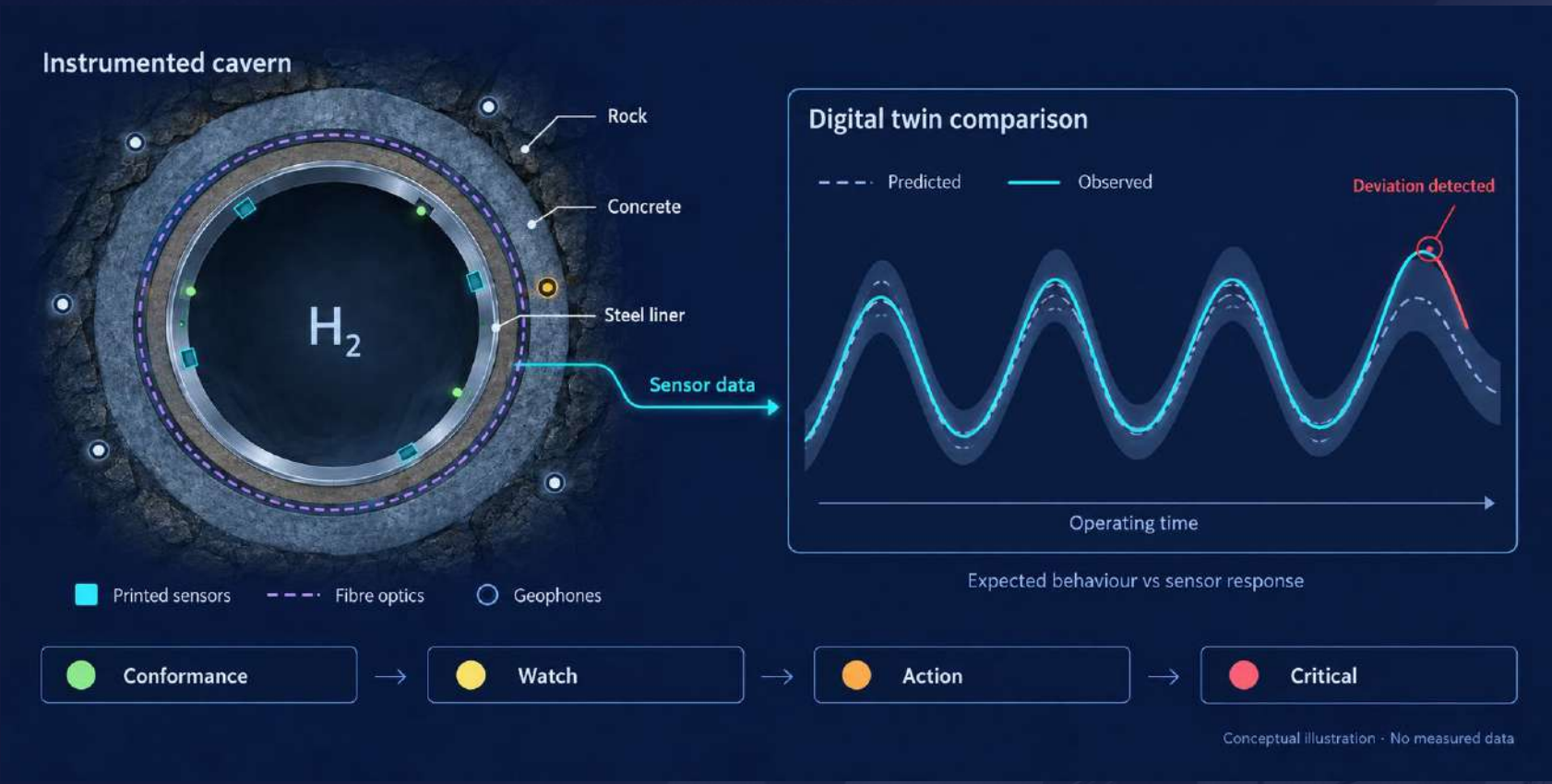
WP3 Numerical simulations (TU Delft)

Develop, validate, and optimize advanced numerical (including open-source) simulation tools.
Guide design, operation, and safety strategies.



WP4 Safety monitoring and risk assessment (COMEC)

Design, validate, and implement a conformance monitoring system tailored to LRCs storing hydrogen, integrating sensor technologies and digital twins

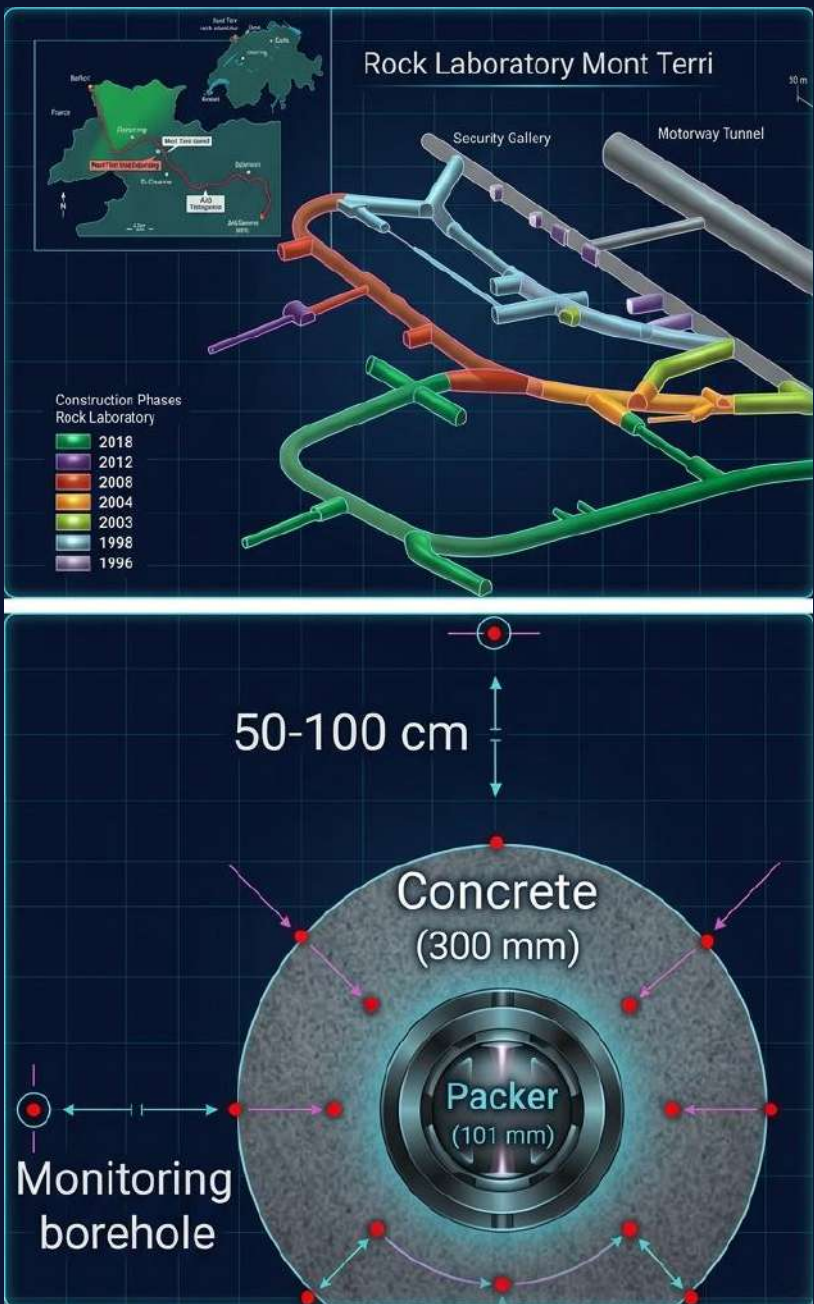
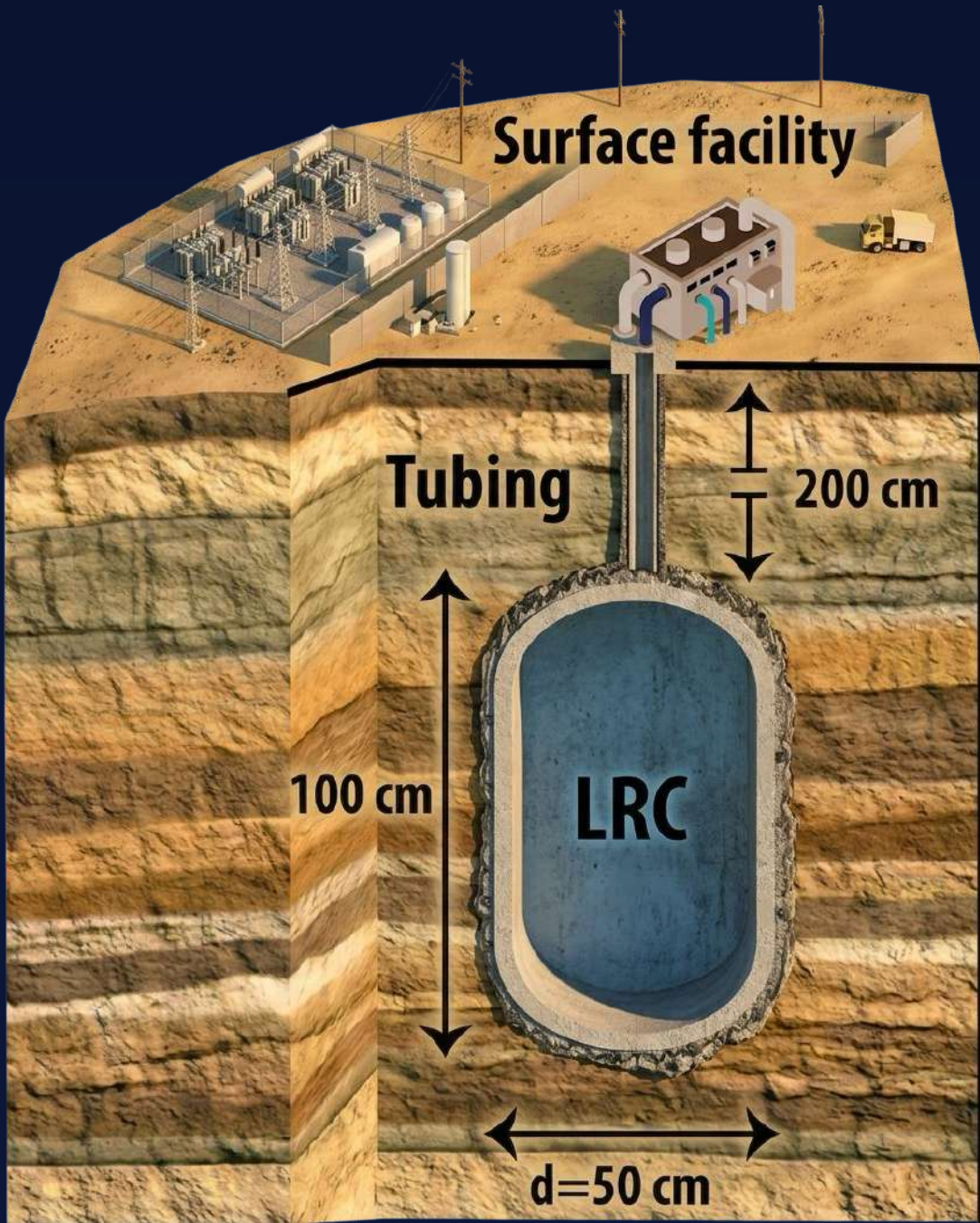


WP5 Validation and proof of concept (SINTEF)

Validate the LRC system's subsurface and non-subsurface components via integrated field tests.

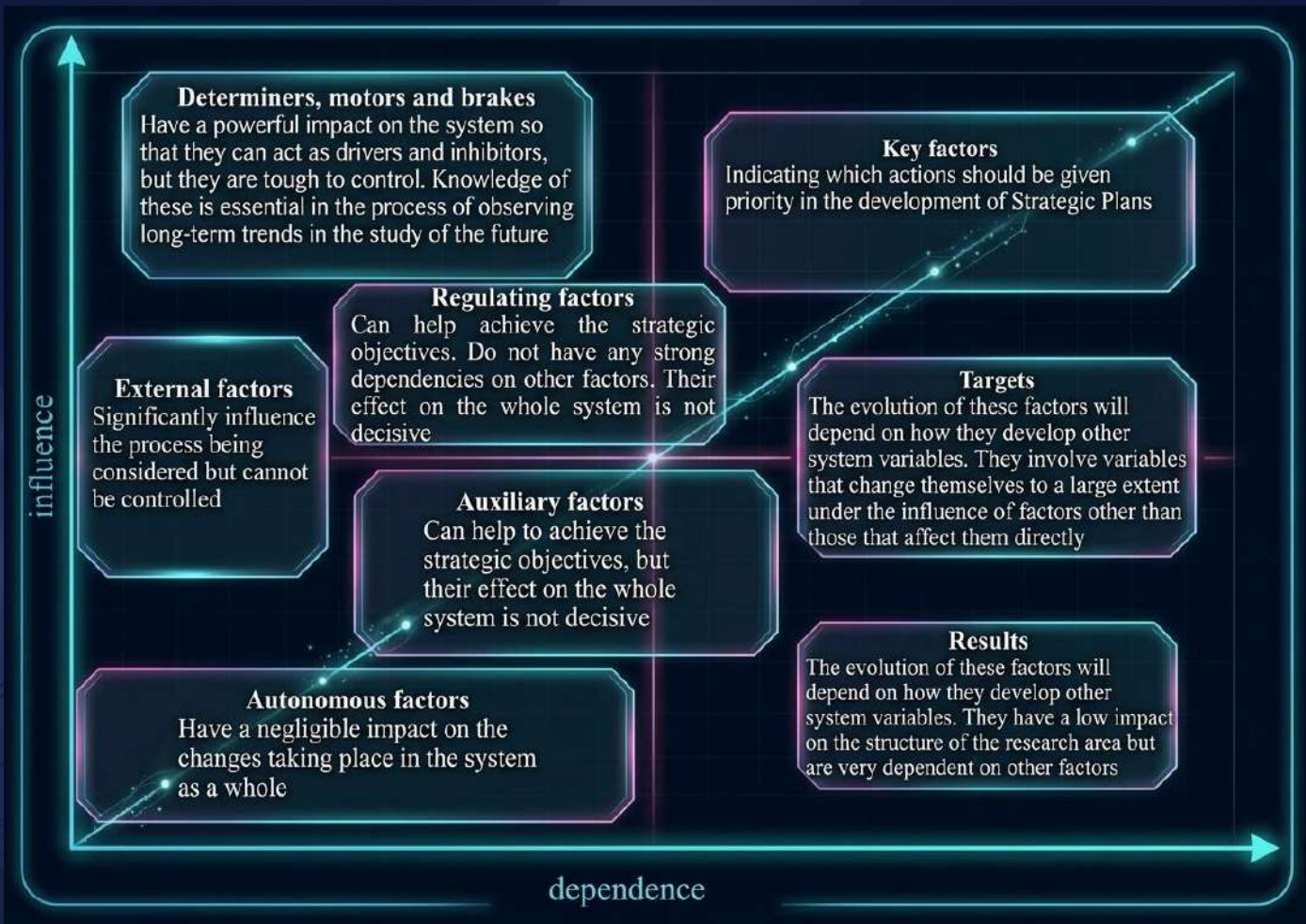
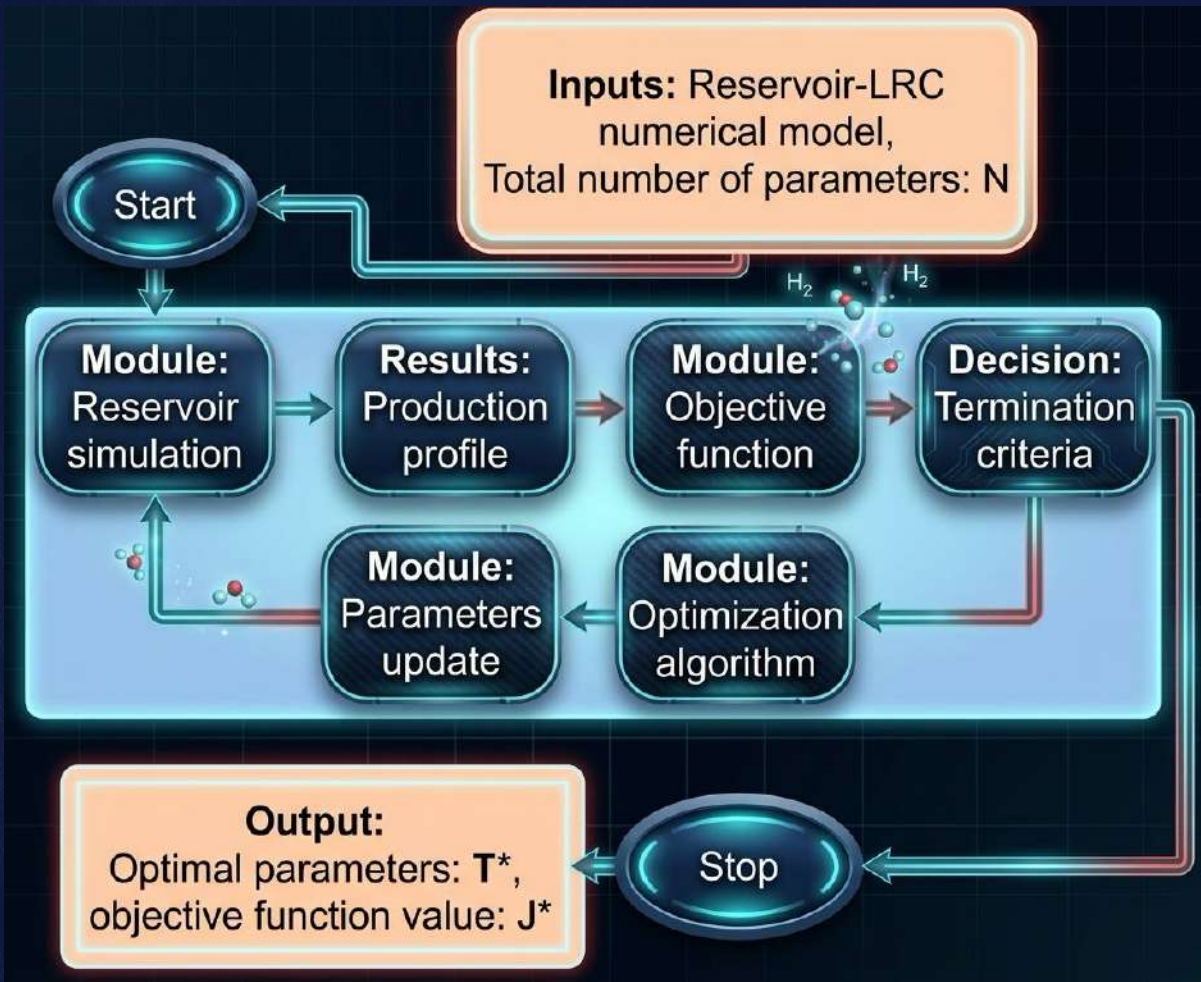
Small scale buried canister in Spain (FHA).

Fatigue test with embedded and remote sensing in Switzerland (Swisstopo/Mont Terri).



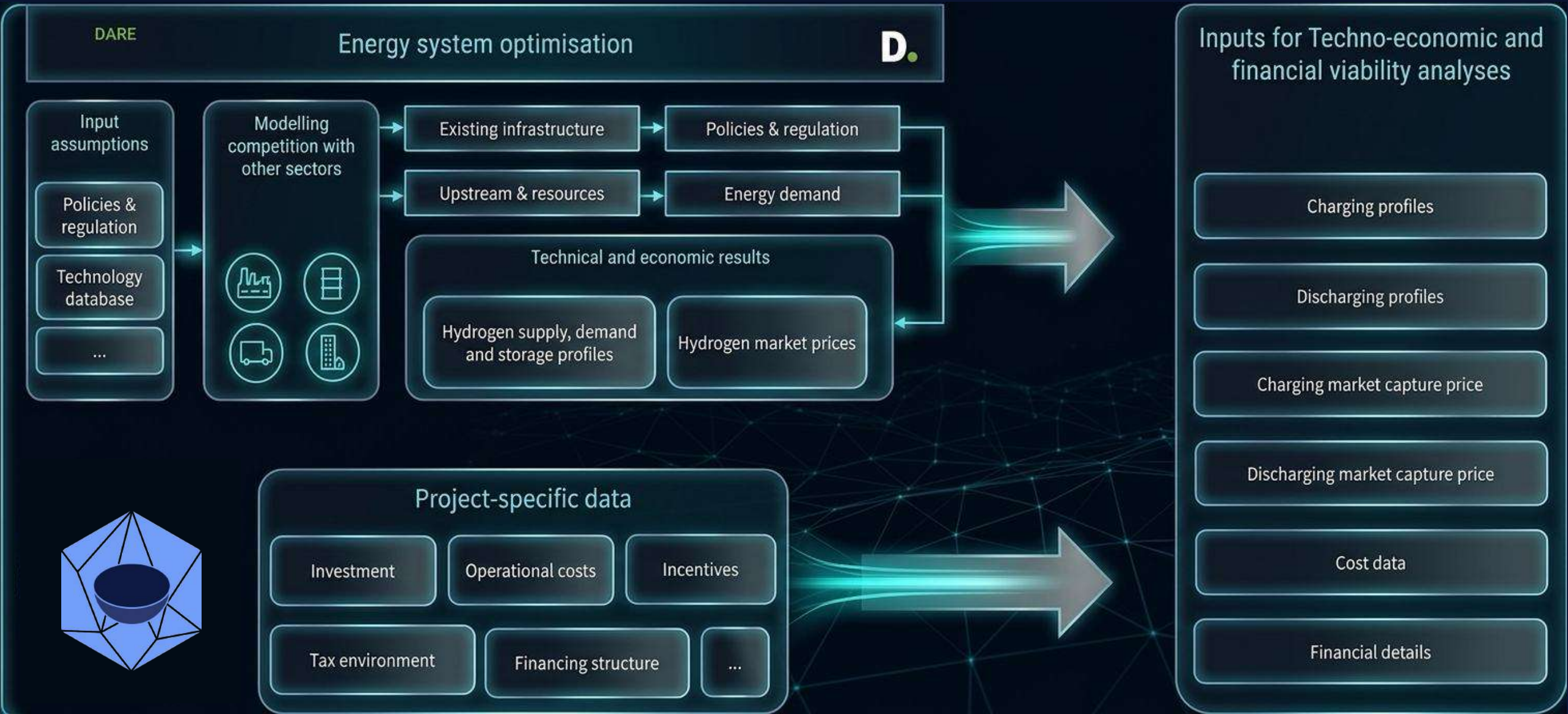
WP6 Replicable guidelines toolkit (AGH)

Develop a decision-support toolkit to help storage system operators in the selection of the optimum storage sites



WP7 Techno-economic analyses (Deloitte)

Conduct techno-economic analyses for on-grid, off-grid, and hybrid hydrogen storage use cases



HyCavern in a nutshell

- ✓ Mitigate cyclic load- and hydrogen-specific risks
- ✓ Automate cavern construction and maintenance with a mobile robotic system that combines laser welding and coating
- ✓ Adapt cavern designs to diverse lithologies.
- ✓ Implement conformance-based monitoring method.
- ✓ Quantify economic value across storage use cases through comprehensive techno-economic analysis
- ✓ Deliver a practical, replicable guideline toolkit

