



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

MULTHYFUEL project **- Multi-fuel refueling** **stations**

Online workshop on
Safe Storage of Compressed Gas
Hydrogen

in road transport applications
and related infrastructure

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MultHyFuel – Purpose and Structure

General description



With increasing demand for FCEV, HRS are required to be upscaled and co-located alongside conventional fuels.

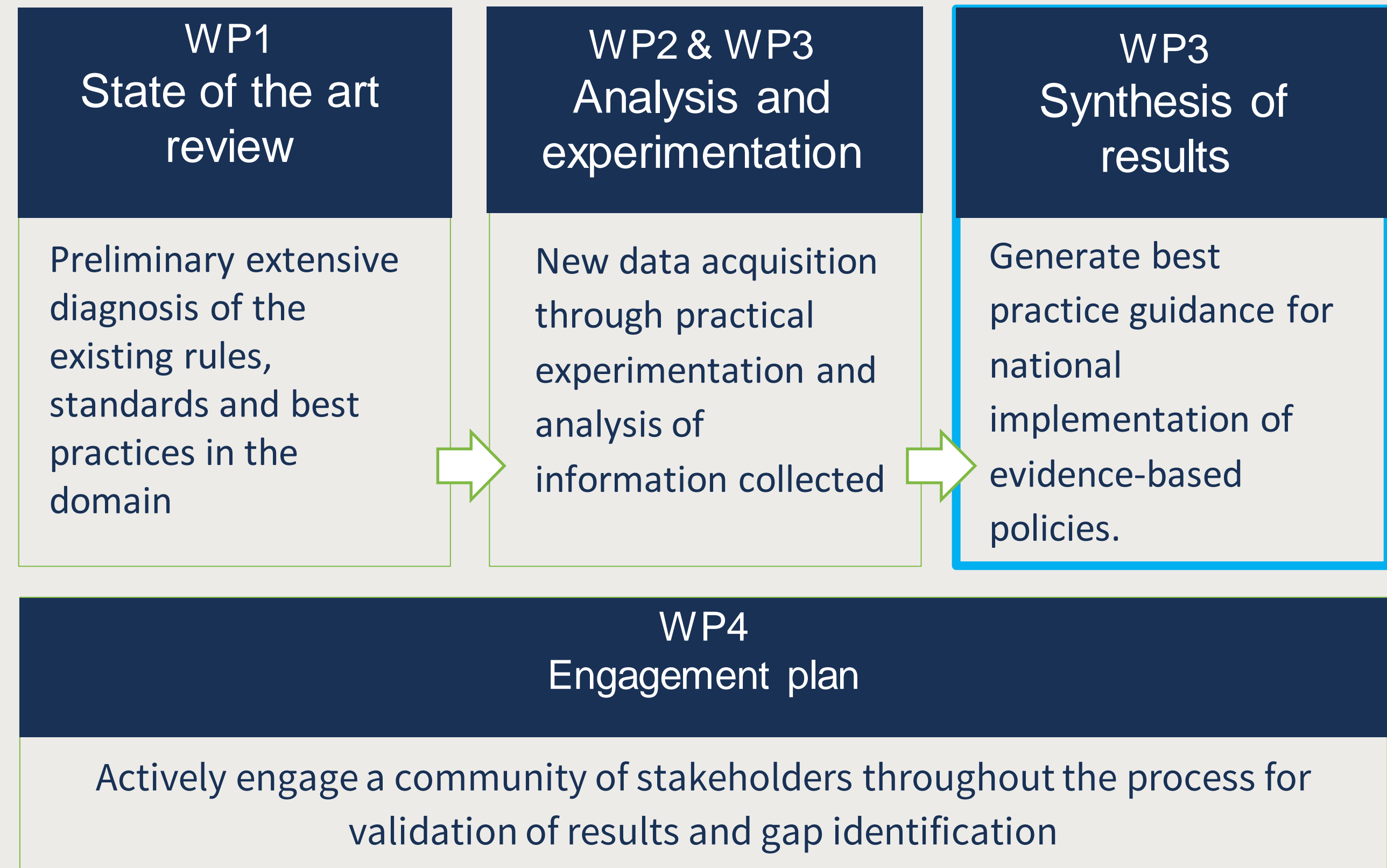
However

- Co-location of hydrogen with conventional fuels is not seen in most safety regulations
- Different approaches are taken by different countries

Project Goals

Defining **commonly applicable, effective, and evidence-based guidelines** to facilitate the construction of HRS in multi-fuel refuelling stations, thanks to

- Practical, theoretical and experimental data
- Active and continuous engagement with key stakeholders



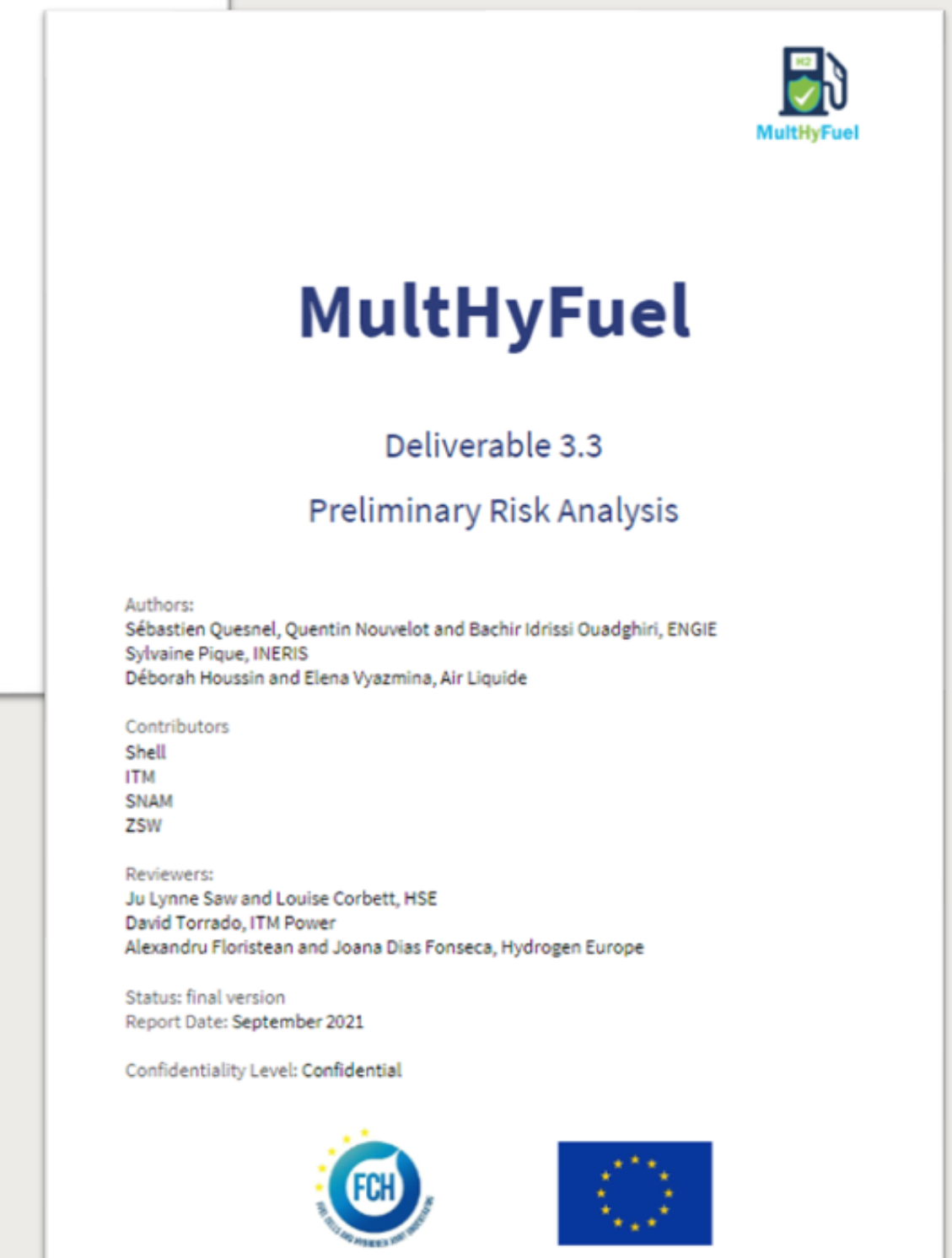
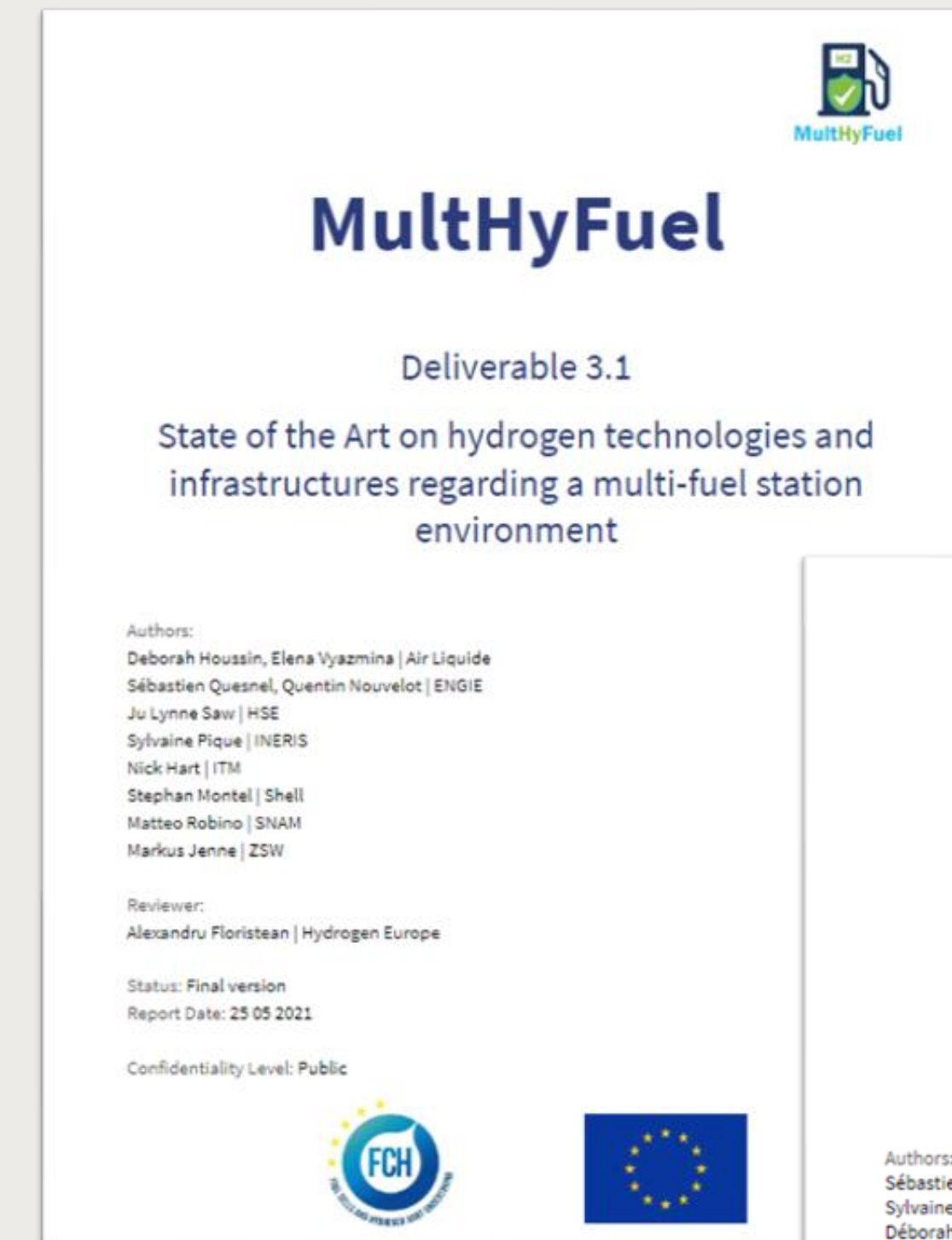
WP3 – SoA and Risk Analysis

General concerns



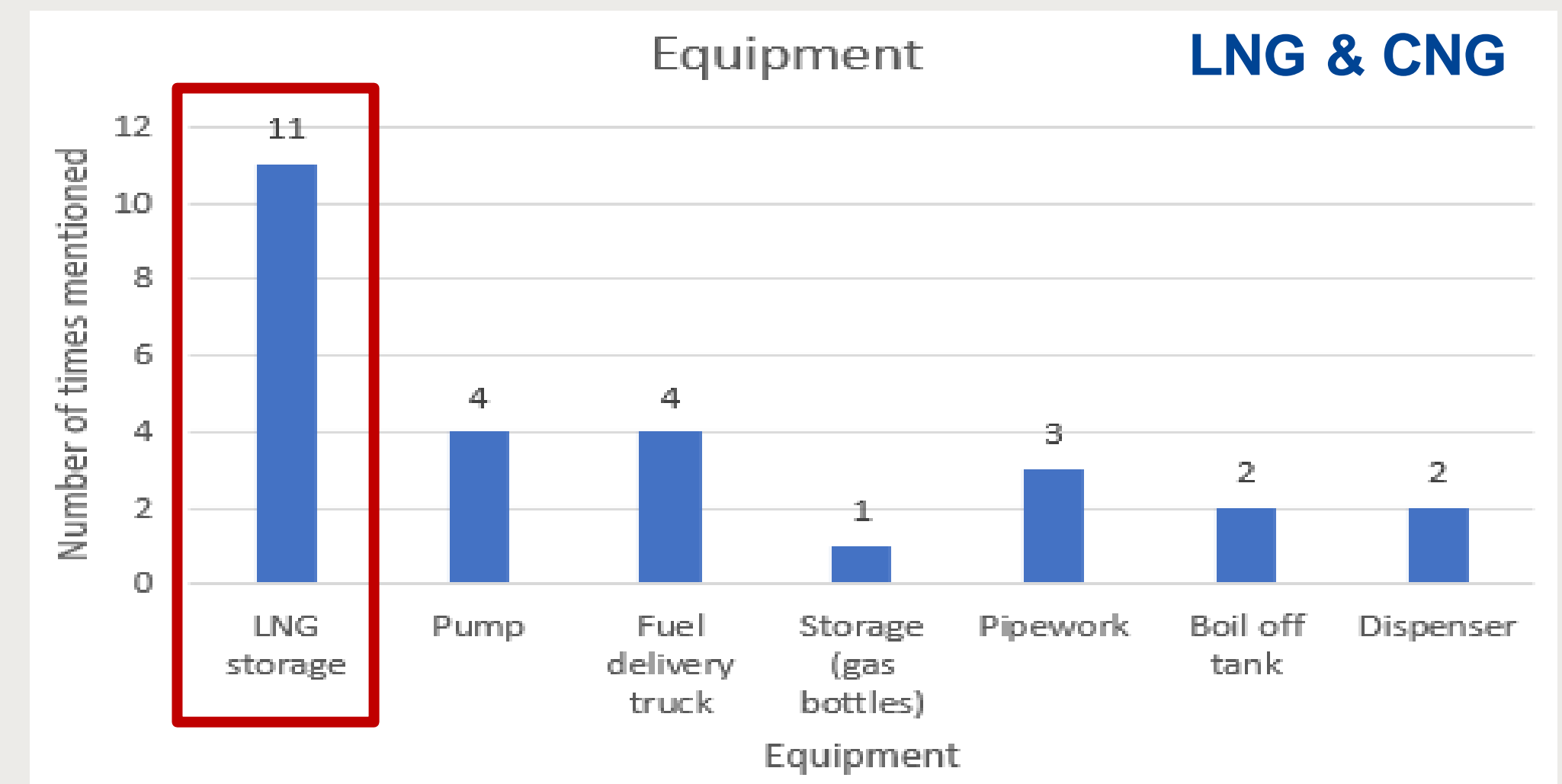
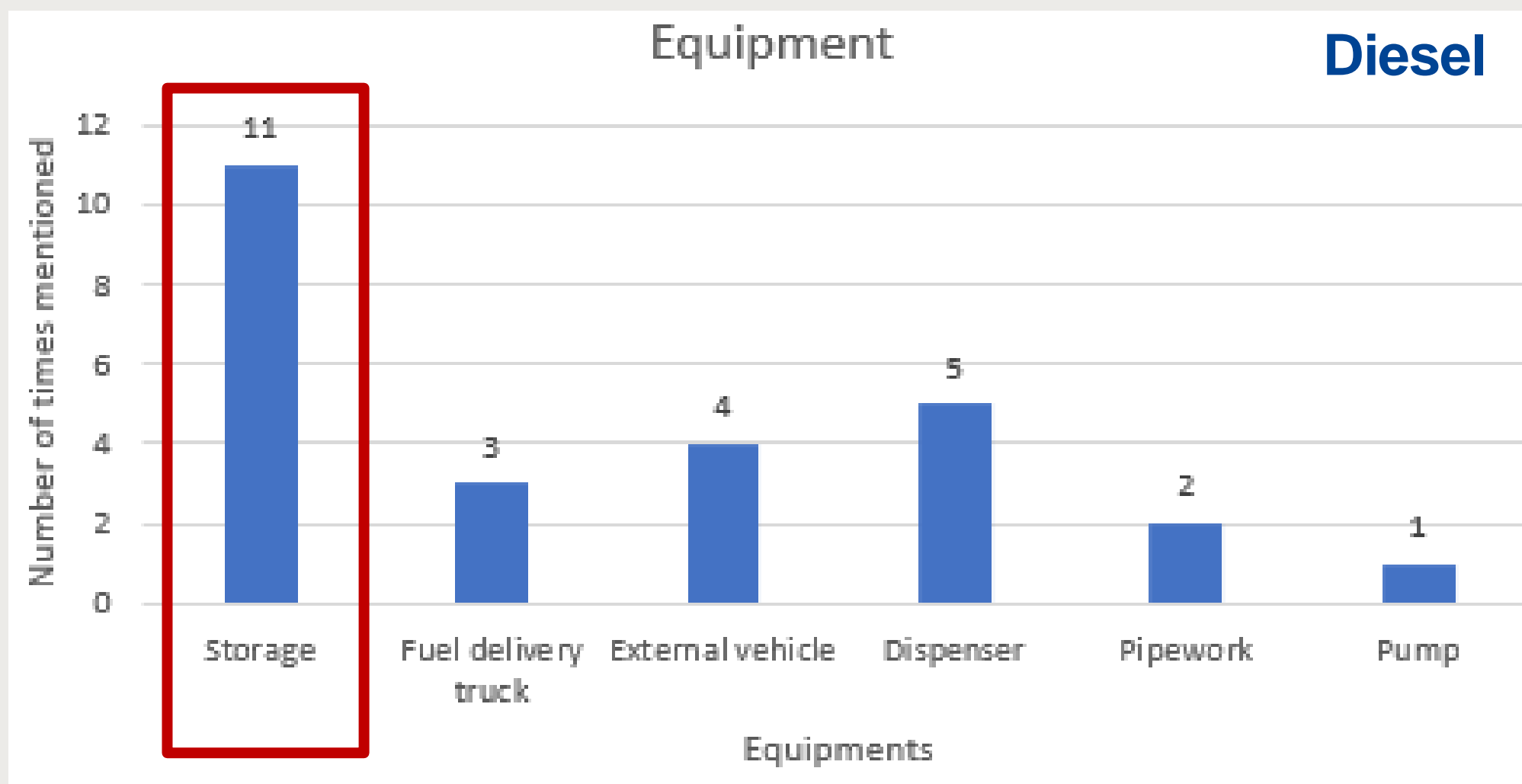
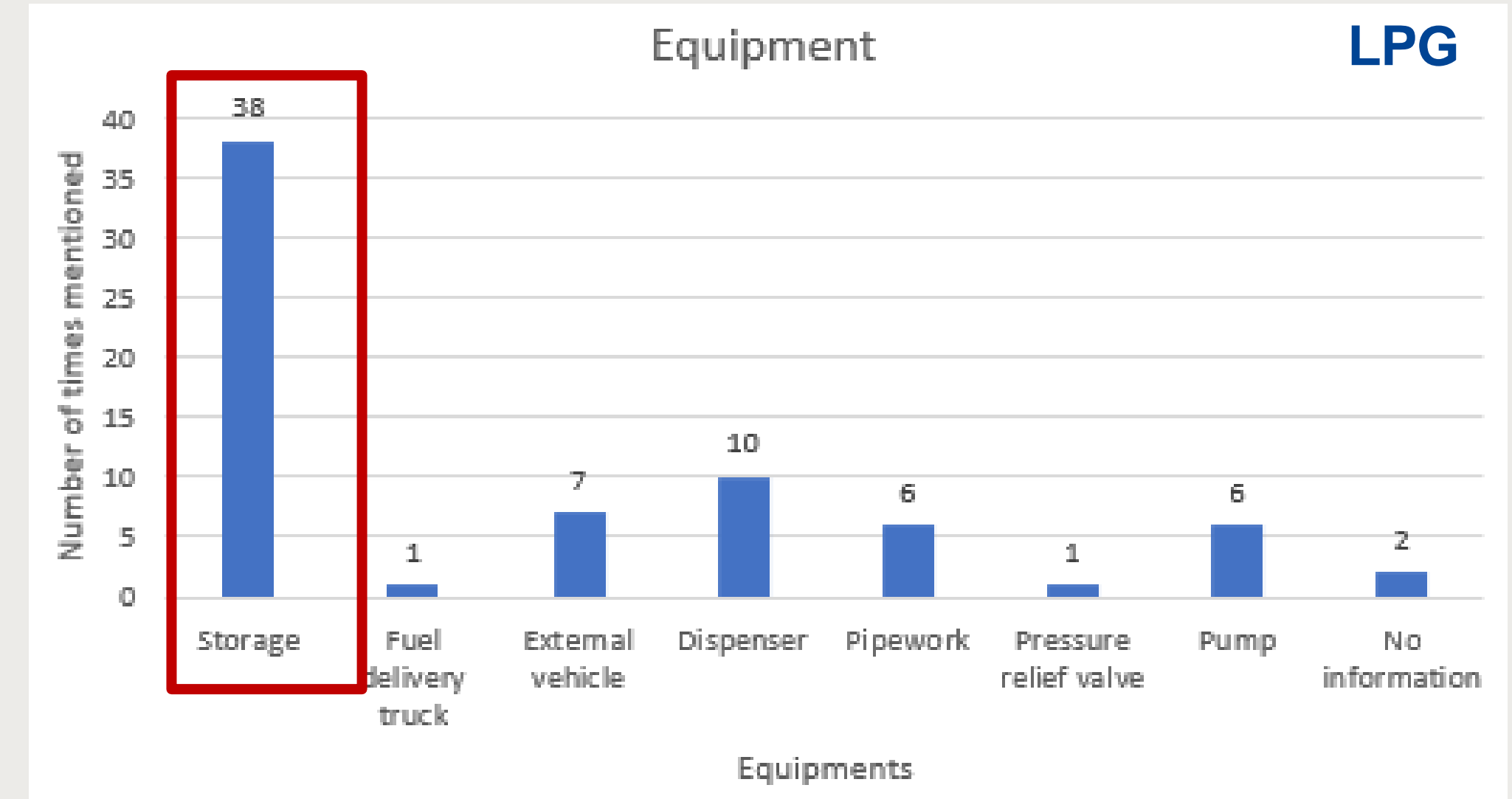
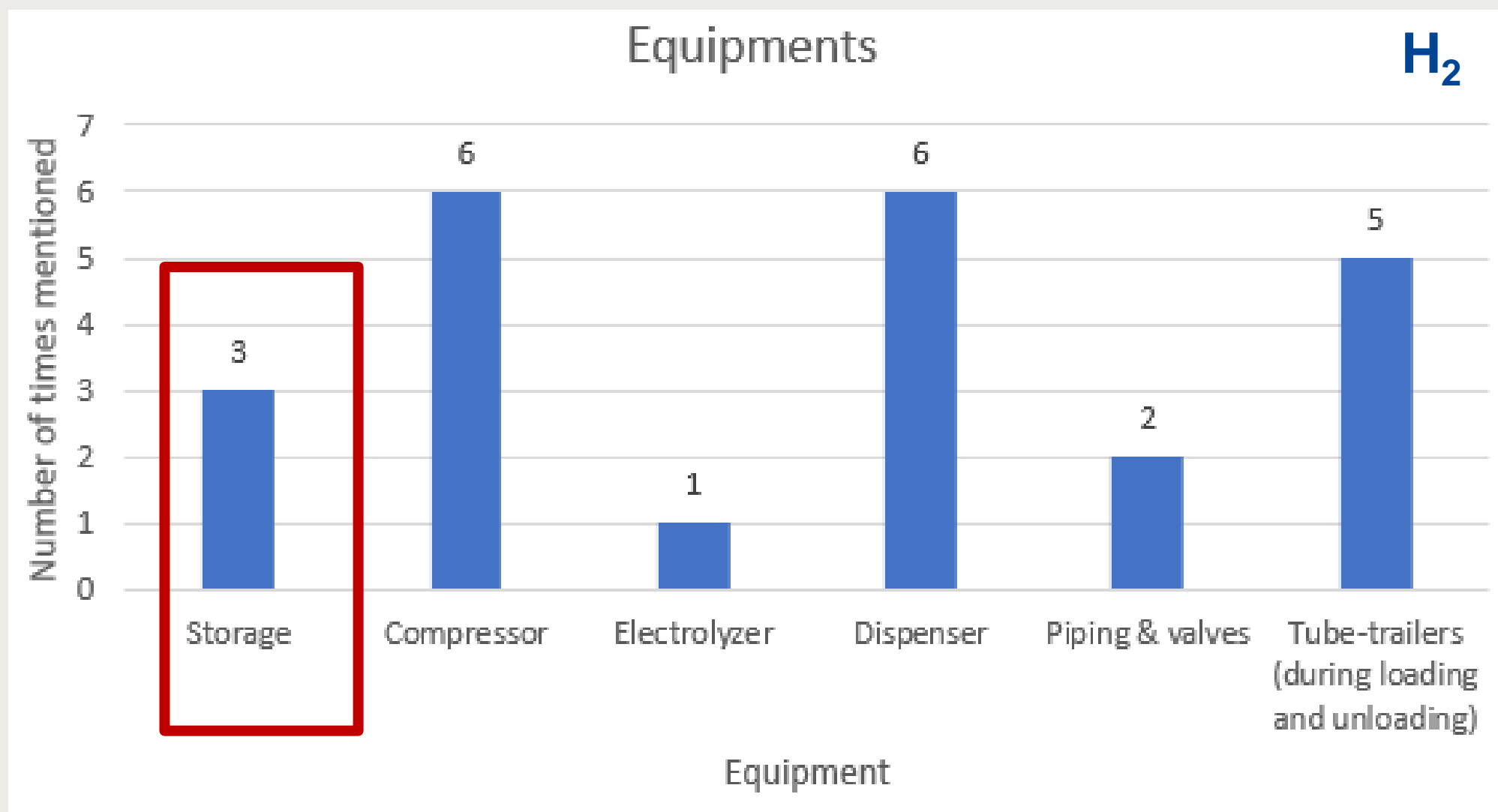
Hazard potentials for process and equipment

Equipment	Operating conditions	Associated hazards
H₂ storage		
Stationary storage tank	Operating phase	ATEX formation due to H ₂ /air mixture in the capacity
	Maintenance	Loss of H ₂ containment Capacity burst Release at vent line exit
Compression		
Compressor	Operating phase	Loss of H ₂ /oil containment ATEX formation due to H ₂ /air mixture in the capacity
	Maintenance	Burst of the compressor Oil injection in the H ₂ pipe // H ₂ in the oil pipe Leakage of H ₂ in coolant (exchanger)
H₂ delivery		
Mobile storage Trailers / Bundles	Loading, in parking space	Loss of H ₂ containment on trailer or bundles
		Capacity burst Release by TPRD
H₂ dispensing		
Hose / Piping	Operating phase	Burst
	Maintenance	Loss of H ₂ containment on hose/piping ATEX formation due to H ₂ /air mixture in hose/piping



Statistics on accidents – H₂ vs Conventional Fuel

INERIS & H2Tool



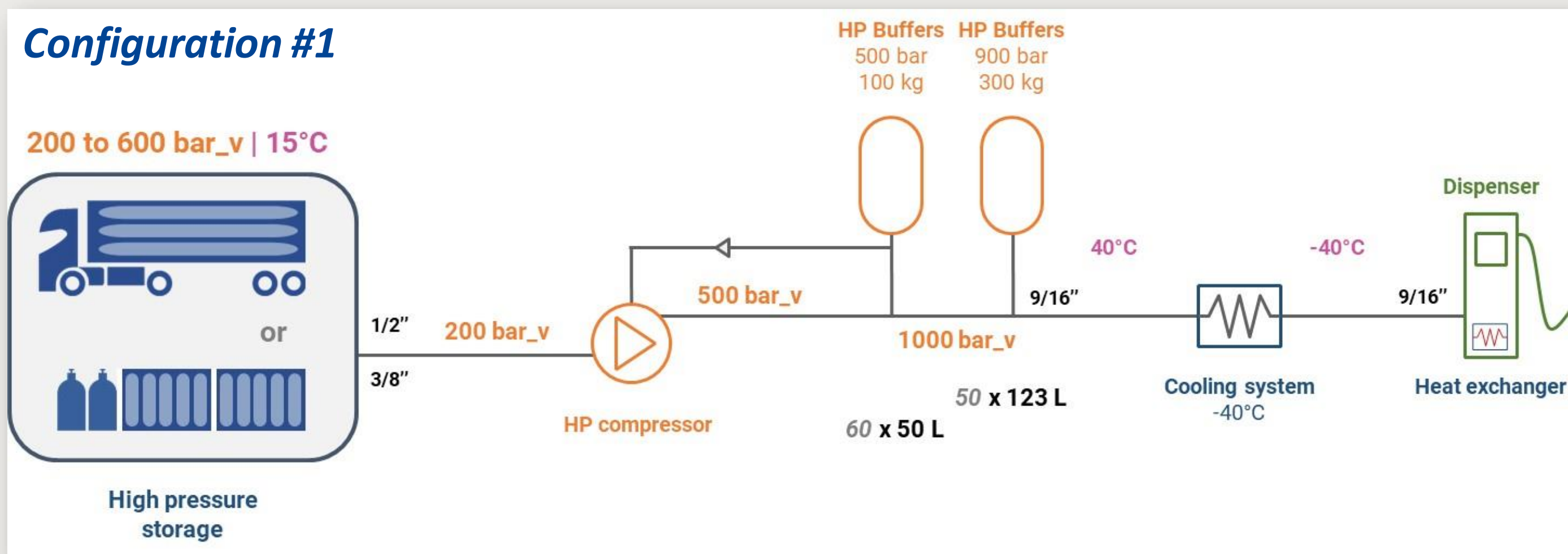
HAZard IDentification

Example of HAZID with Configuration #1



For the project, three realistic and specific configurations were retained

- Configuration #1 – **Ready-to-deploy** multi-fuel station
 - Based on existing, « simple » and already used technologies – 1 t-H₂ stored
- Configuration #2 – **On-site H₂ production** multi-fuel station
 - Based on on-site hydrogen production and associated requirements – 2 t-H₂
- Configuration #3 – **High capacity & High filling** multi-fuel station
 - Based on future large needs of hydrogen for mobility – 4 t-H₂



Root causes for

- **Rupture of the hydraulic system on crane** on hydrogen bundles trucks,
- **Movement of truck or the drop of bundles,**
- **Delivery of higher pressure** (trailer or bundle),
- **Decoupling hose under pressure,**
- **Bad connection of the hose** (dirt in connection part, under or over tightening, hose at the bad location...) or the wrong hose
- **Back flow** for the equipment before compressor,

Main Dangerous Phenomena for hydrogen storage

- Jet fire
- Flash fire
- Vapour Cloud Explosion (VCE)
- Unconfined Vapour Cloud Explosion (UVCE)
- Burst



⇒ 33 Major Phenomena for Storage were identified

Example of recommendations for prevention/protection barriers

Existing safety features on HRS: with a focus on the Storage



What	Prevention barrier	Protection barrier
Supply storage: loss on containment on bundles/MCP	<ul style="list-style-type: none"> - Check the control of H₂ trailers/bundles have been implemented by the supplier 	<ul style="list-style-type: none"> - Fire detection system with clear procedure of what to do for each size leak and DPh (for example isolation system/ move people (depend where is the leak) ...) - Gas detection (ultrasonic system) with clear procedure of what to do for each size leak and DPh (for example isolation system/ evacuation (depending on where the leak is))
Supply storage: release by TPRD	<ul style="list-style-type: none"> - To review the location of venting of TPRD - Safety distance between the canopy and the the tube trailer (layout) - Take into account the location of the release (vent line) 	
Supply storage: loss on containment on hose	<p>Check the control of H₂ hose has been implemented by the supplier</p>	<ul style="list-style-type: none"> - Isolation valve in case of emergency - Restrictive orifice - Fire detection system with clear procedure of what to do for each size leak and DPd (for example isolation system/ move people (depend where is the leak) ...) - Gas detection (ultrasonic system) with clear procedure of what to do for each size leak and DPh (for example isolation system/ evacuation (depending where the leak is))
H₂ buffer: loss of containment on storage/ piping	<ul style="list-style-type: none"> - Record of fueling cycle and alarm when the maximum cycle is nearly reached 	<ul style="list-style-type: none"> - Fire detection system with clear procedure of what to do for each size leak and DPh (for example isolation system/ move people (depend where is the leak)) - Gas detection (ultrasonic system) with clear procedure of what to do for each size leak and DPh (for example isolation system/ evacuation (depending where the leak is))
burst of buffer	<ul style="list-style-type: none"> - Review the design of storage (open structure on the top placed underground) 	

*DPh Dangerous Phenomenon





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