FUELS INDUSTRY
Association of South Africa

Renewable Energy Hydrogen
Fire protection measures for Hydrogen Refueling Stations

15 May 2025

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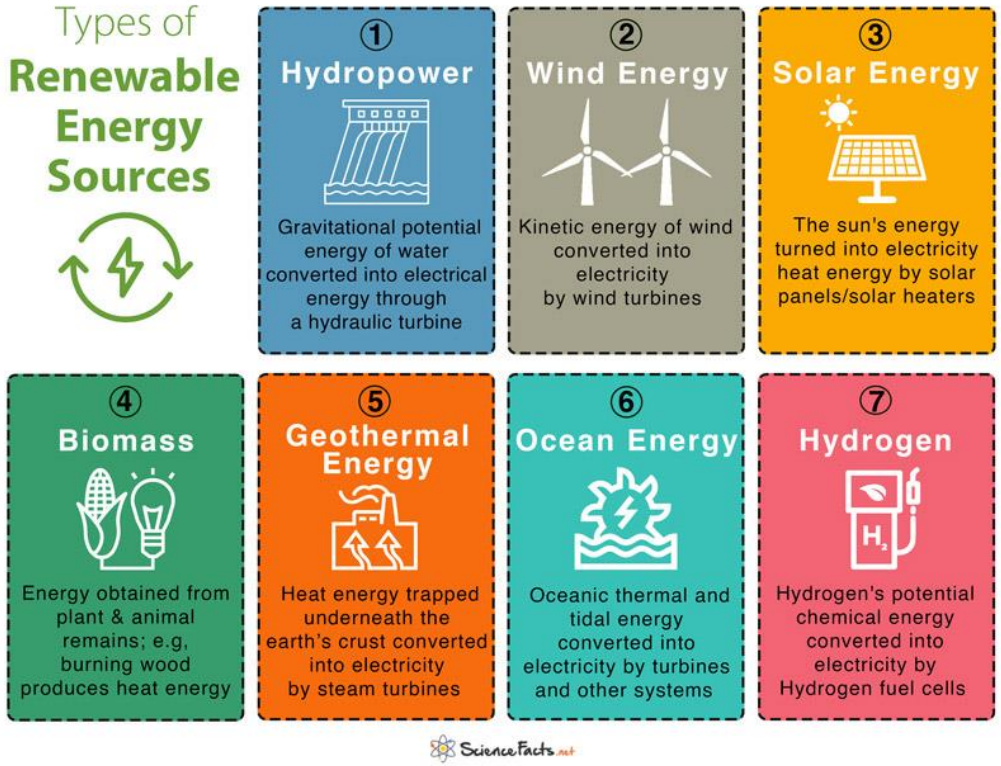
2024

Renewable Energy Hydrogen

+ **There are 7 Types of Renewable Energy**

- Solar
- Wind Energy
- Hydroelectric
- Ocean Energy
- Geothermal Energy
- Biomass
- Hydrogen



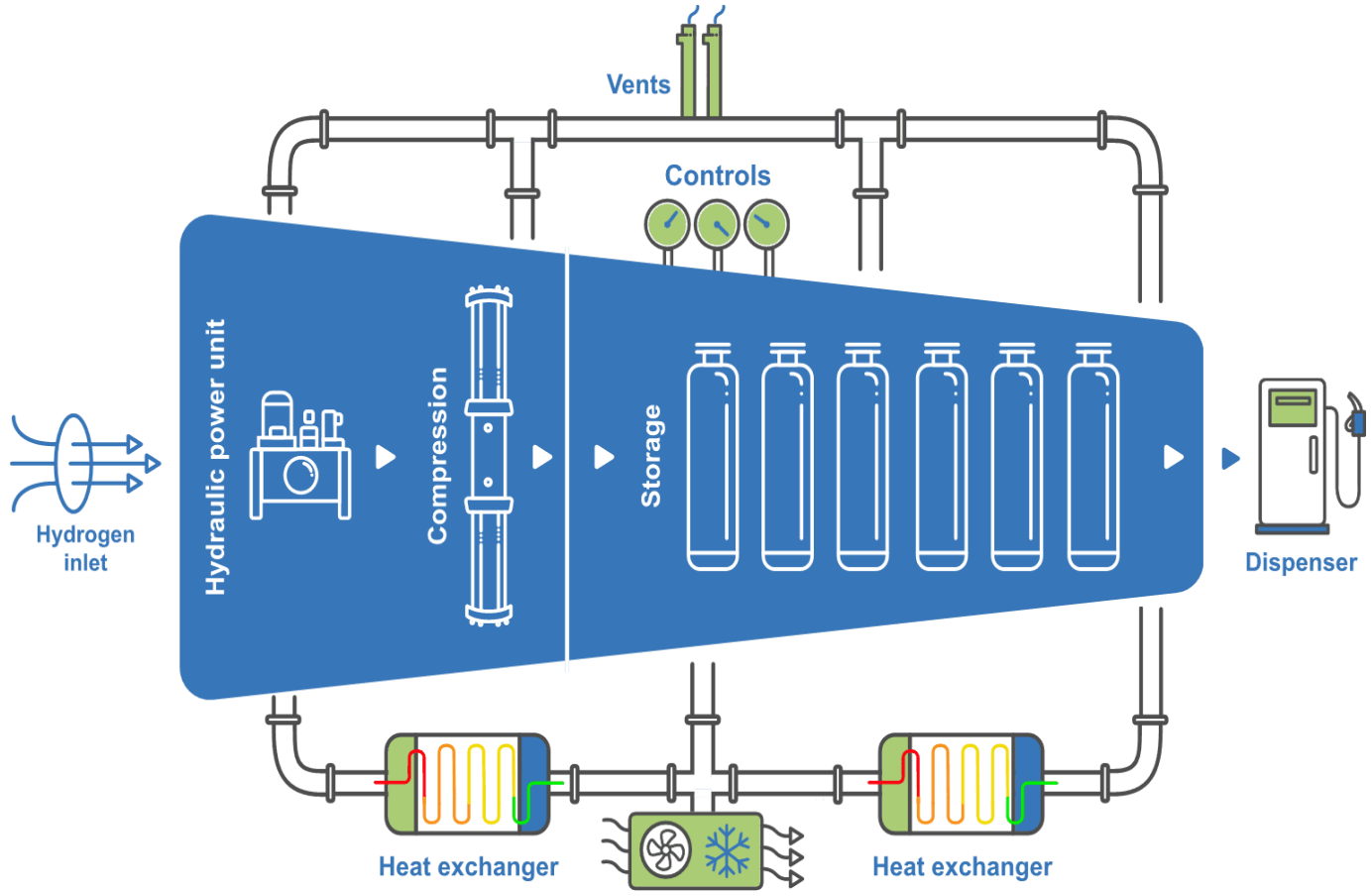
Renewable Energy Hydrogen

- In simple terms, an HRS is a station for refilling hydrogen. Hydrogen fuel cell vehicles can be refueled quickly at a refueling station. A regular HRS consists of hydrogen storage tanks.
- Hydrogen gas compressors, a pre-cooling system, and a hydrogen dispenser can dispense hydrogen at pressures of 350 bar, 700 bar, or dual pressure, depending on the type of vehicle being refueled. A typical hydrogen car can be refueled in three minutes, while a bus takes about seven minutes

Renewable Energy Hydrogen

Unlike conventional filling stations, hydrogen is sold by the kilo, not by the liter. The refueling time for a conventional bus, which usually has a capacity of between 30 and 37.5 kilos, is no more than 12 minutes.

Regarding hydrogen bus consumption, it is estimated at approximately 8 kilos per 100 kilometers. Therefore, the range of hydrogen vehicles currently on the market would be around 400 kilometers.



Safety Measures

- **Site Layout and Separation Distances**: Recommend minimum separation distances between hydrogen storage/dispensing equipment and other structures, ignition sources, or public areas to limit exposure to potential blast or fire hazards.

- **Hydrogen has unique hazards**, such as high flammability, low ignition energy, and potential for leaks due to its small molecular size. The design, installation, operation, and maintenance of these facilities must mitigate risks like fire, explosion, and equipment failure.

- **Equipment Design and Integrity**: Standards specify requirements for hydrogen storage tanks, piping, valves, and dispensers to ensure they are designed for high-pressure or cryogenic conditions (e.g., 350 or 700 bar for gaseous hydrogen). This includes material compatibility to prevent hydrogen embrittlement and robust leak detection systems.

- **Ventilation and Gas Detection**: Given hydrogen's tendency to rise and accumulate in confined spaces, adequate ventilation systems and continuous gas detection are essential to identify leaks early and prevent explosive concentrations (hydrogen's flammable range is 4% to 75% in air).

- **Fire Suppression Systems**: Fire suppression systems, such as water deluge or foam, should be tailored to hydrogen fires, which burn invisibly and require specific extinguishing methods. Passive protection, like blast-resistant construction, is also advisable.

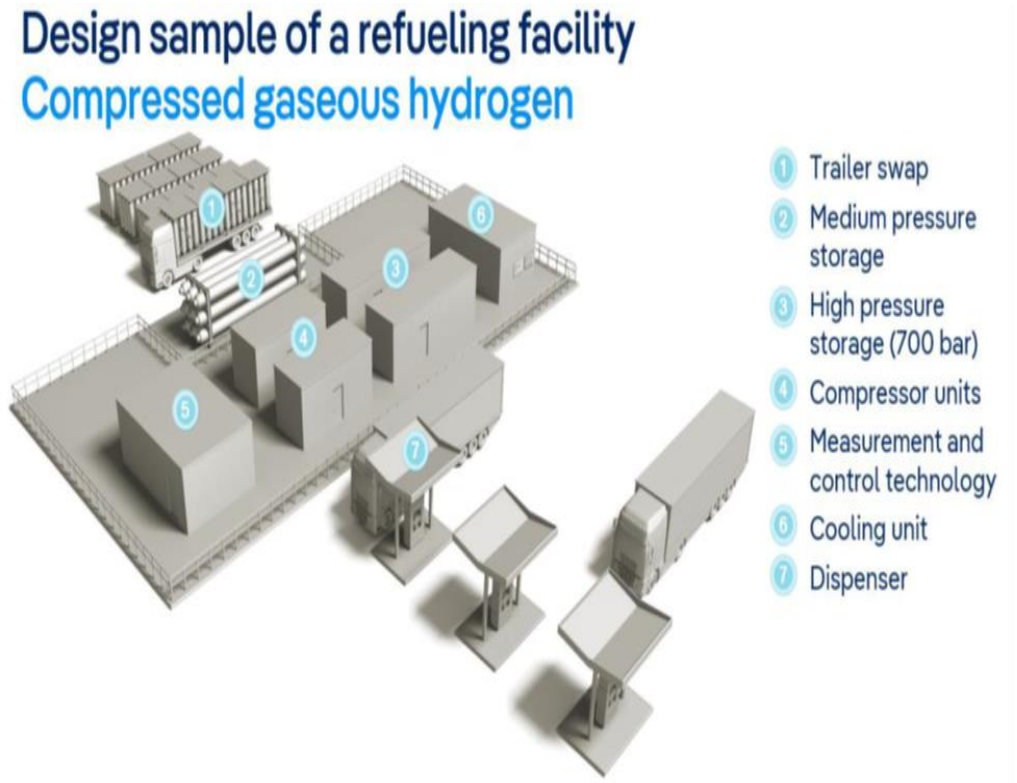
- **Emergency Planning:** Emergency planning should include pre-fire plans, contingency planning, and detailed emergency response procedures. This encompasses shutdown protocols, evacuation routes, and coordination with local fire services

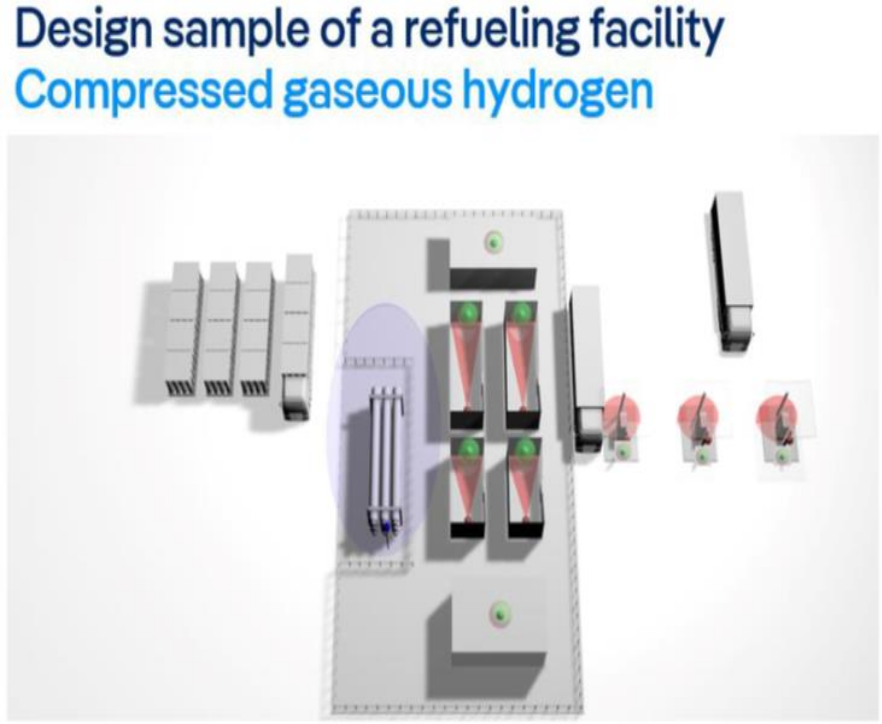
Significant Fire Incidents

Table 1: Summary of Significant Fire Incidents

Date	Location	Description	Cause	Consequences
Aug 21, 2008	United States (assumed)	Fire at hydrogen fueling station during operation, starting in compression skid	Failed weld on pressure switch, cascading to line failures and combustion	Compressor skid lost, moderate damage to surrounding equipment, no injuries
May 4, 2012	United States (assumed)	Fire due to pressure relief device failure, hydrogen ignited at vent pipe	Incompatible materials and improper assembly of pressure relief valve	Burned for 2.5 hours, < $300 damage to canopy roof, no injuries, station closed for 9 months
Jun 10, 2019	Sandvika, Norwary	Fire and explosion at hydrogen filling station, hydrogen leak from high-pressure storage	Assembly error (inadequate torque of inner bolts)	Minor injuries from triggered car airbags, no major damage, stations idled temporarily
Jun 25, 2024	Gersthofen, Germany	Fire and explosion at newly opened hydrogen filling station, loud bang and large flame	Technical defect, cause under investigation	Quickly extinguished, no injuries, station closed for investigation

Potential Location of Detectors





INCIDENT

- South Korea experienced explosions at two separate hydrogen filling station.
- This incident was initially reported as an explosion but was later clarified to be a fire caused by a hydrogen leak from a safety valve

INCIDENT

- Three people were injured — one seriously — after a Hyundai hydrogen bus exploded at a refueling station in central South Korea. According to local reports, an “F” warning light on the bus’s dashboard had been coming on since the previous weekend, indicating a problem with the fuel-cell stack. Hyundai advised the bus operator to take the vehicle to a nearby service center for inspection.

- However, the bus needed refueling before its journey, so the driver and mechanic drove to a local hydrogen refueling station in the Mokhaeng-dong part of the city.

INCIDENT

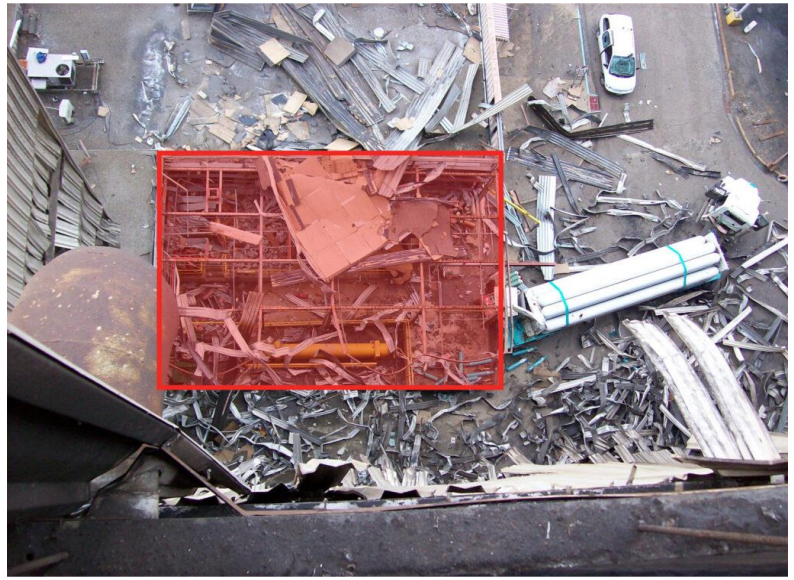
- A truck trailer carrying hydrogen cylinders exploded on August 26 at an industrial gases facility at the Leuna Chemical Park in eastern Germany due to a suspected, unexplained hydrogen leak. Although no one was hurt in the deflagration, all trailers of the same type have been taken out of circulation until the cause of the leak has been identified

INCIDENT ROOT CAUSE

- A new hydrogen refueling station (HRS) in southern Germany has been severely damaged after an explosion caused a fire at the facility. The incident was likely caused by a technical defect, with initial findings pointing to an explosion on a compressor

INCIDENT

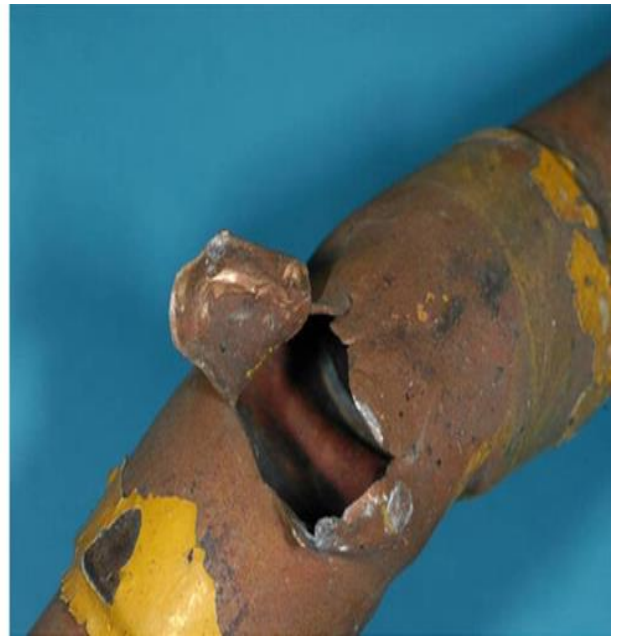
- After a rupture disk failed, hydrogen lost containment in the vent piping and rapidly leaked into the air under an overhead awning. Hydrogen should have escaped through a properly designed vent system and harmlessly dissipated into the environment above the awning. Instead, the pressurized gas caused the vent system to fail, allowing hydrogen to escape.



Hydrogen gas then accumulated under an improperly designed overhead weather awning before igniting. Multiple potential ignition sources were identified in the awning

INCIDENT

- The rupture disk rating was based on a US Department of Transportation (DOT) set pressure instead of the American Society of Mechanical Engineers (ASME) rated pressure, which was required for this vessel. The rating on the rupture disk was improperly set between 3600 to 4000 psi, even though the vessel was rated for only 2450 psi. However, while this set pressure was improper for an ASME-rated vessel, the rupture disk rating was not the cause of the failure. Due to other maintenance failures, the rupture disk failed prematurely at an estimated pressure of 1800 psi during the hydrogen transfer from the tube trailer



Management of change was not followed during the replacement of the rupture disk just six months before the incident. An incorrect disk type was installed, and non-OEM parts with questionable compatibility were used to connect to the original relief body

Referance

Reference

- *NFPA 2 Hydrogen technologies*
- *FM Property Loss Prevention Hydrogen*
- *EN 17127:2021 - Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols*
- *ISO 19880-1:2020 - Gaseous Hydrogen — Fuelling Stations — General Requirements*

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Thank You

2024