NEEST

NEW ENERGY & ENVIRONMENTAL SOLUTIONS AND TECHNOLOGIES

# TETHYS WEBINAR – GREEN HYDROGEN PRODUCTION

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# H2 APPLICATIONS: SAFETY

Typical examples - cases

# Hydrogen safety

- All fuels (or energy carriers) (like Gasoline, Coal, CNG, LNG, $H_2$) have „safety" issues (otherwise they wouldn't be used as fuels)
- According to the specific characteristics of each energy carrier, appropriate safety measures are developed
- Hydrogen is a (light) gas and shares similarities with natural gas
- The utilization and safety measures for natural gas are well known and may be considered as a good first approximation for the use of hydrogen

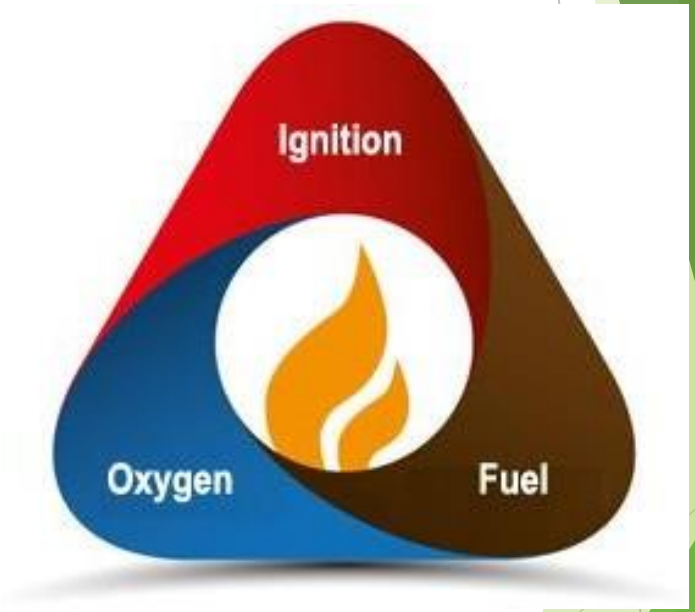
# Hydrogen safety: Basic principle (as in all fuels)

**Explosion conditions**

- Fuel
- Oxygen
- Ignition source

All three factors must be present in sufficient quantity for a fire to occur

**Always avoid ignitable mixtures and ignition sources**




Grafik: www.sentronic.com

# Hydrogen safety: Relevant material data

**Basic principles - hydrogen data** **(and for natural gas)**

- Lower and upper concentration limit for the ignition
  - 4 %... 74% (4.1% ... 16.5%)
- Lower and upper concentration limit for the detonation
  - 13 %... 65%
- Ignition temperature
  - 560°C (575 ... 640°C)
- Minimum ignition energy
  - 0.02 mJ (0.28 mJ)
- Density
  - 0.089 kg/m³ (air density: 1.225 Kg/m³) (0.83 kg/m³)


(EC) No. 1272/2008 [CLP]

# Hydrogen Safety

## Fuel density & distribution in the surroundings

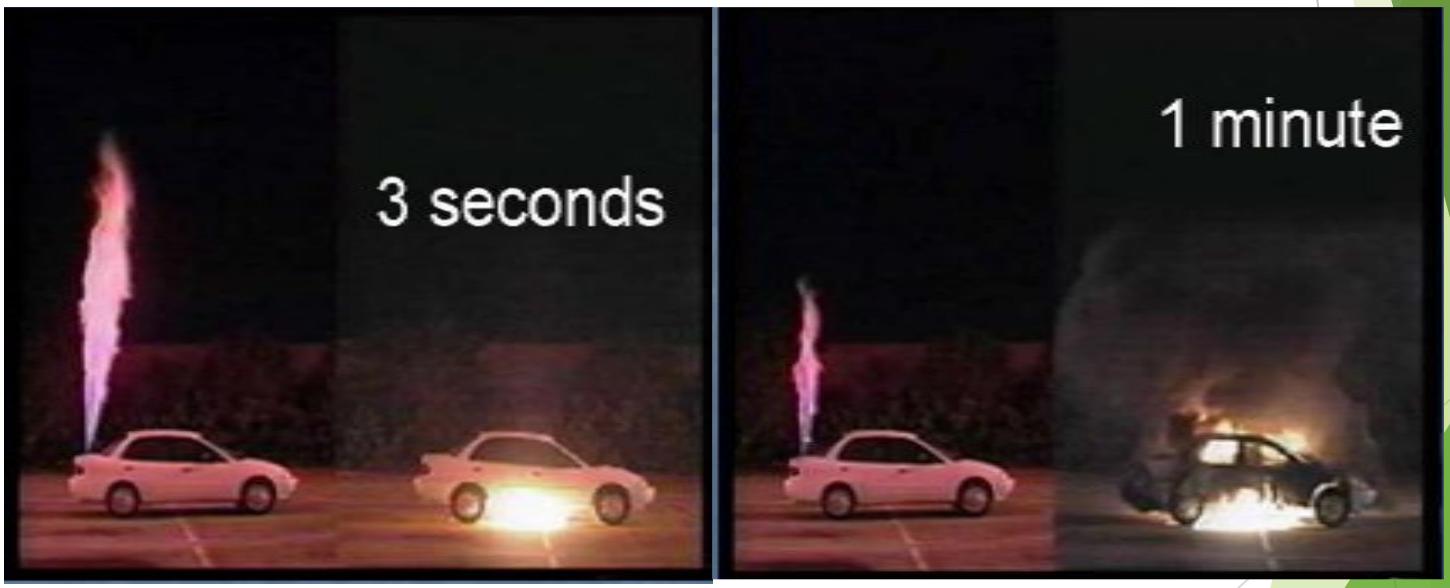
# H2 safety compared to other fuels

**A comparison**

Fire in petrol engine (15,000 vehicle fires in GER/year) and the hydrogen vehicle (left) with leaking tank.


Tesla after a short circuit while charging at a supercharger.

# Hydrogen safety



# Thought experiment on Hydrogen Safety*

In your mind, go to your gas cooker, turn the knob and leave the room. What happens?

## LPG

Gas out of the hob.
Denser than air so drops on top of the floor.
Builds up a mixture of gas and air on the floor till about 2 feet deep.
Spark in the back of the fridge.
Boom - Bye Bye kitchen.

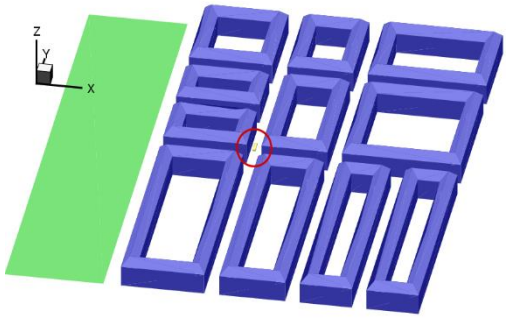
## Hydrogen

Gas out of the hob.
Rises at a speed of about 67 km/h.
Hits ceiling finds a crack and escapes through the roof.
Does not build up a mixture of H2 and air.
Without hermetically sealing the room you cannot build this explosive mixture.
Generally, H2 is not very suitable to create explosive mixture which will then ignite.

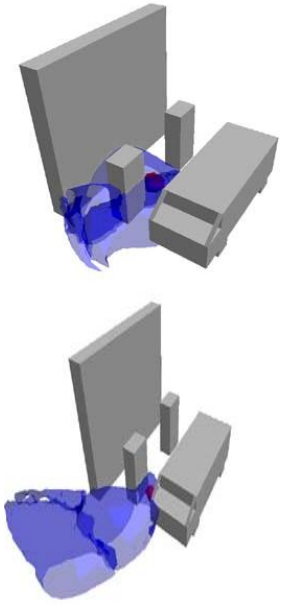
*adapted from Dr. Ch. Dunnill, Swansea Univ., UK

## Simulation Tools: Storage Systems & Safety Studies

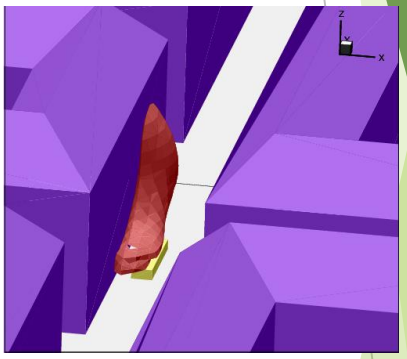
### Safety analysis of hydrogen used as a fuel for vehicles




*The 1983 Stockholm $H_2$ accident. Modeled site and truck carrying 4 kg of $H_2$ in 18x200 lt, 200 bar bottles*



*The 1983 Stockholm $H_2$ accident predicted lower flammability $H_2$-air cloud for 10 seconds after start of accident.*




HySafe HyApproval

# Hydrogen Safety: Summary

## Summary

- Safe operation (as for other fuels) with hydrogen is possible
- Synergies / similarities between natural gas and $H_2$
- Set-up / installation of components in rooms is technically possible and can be safe
- Adapt safety concept according to the application – cost-effective solutions are possible