



**Webinar**

**“Hydrogen Powered Vehicles in Road Tunnels”**

Dutch Knowledge Platform for Tunnel Safety (KPT)

21 January 2021

# **Overview of the interim results of the HyTunnel-CS project**

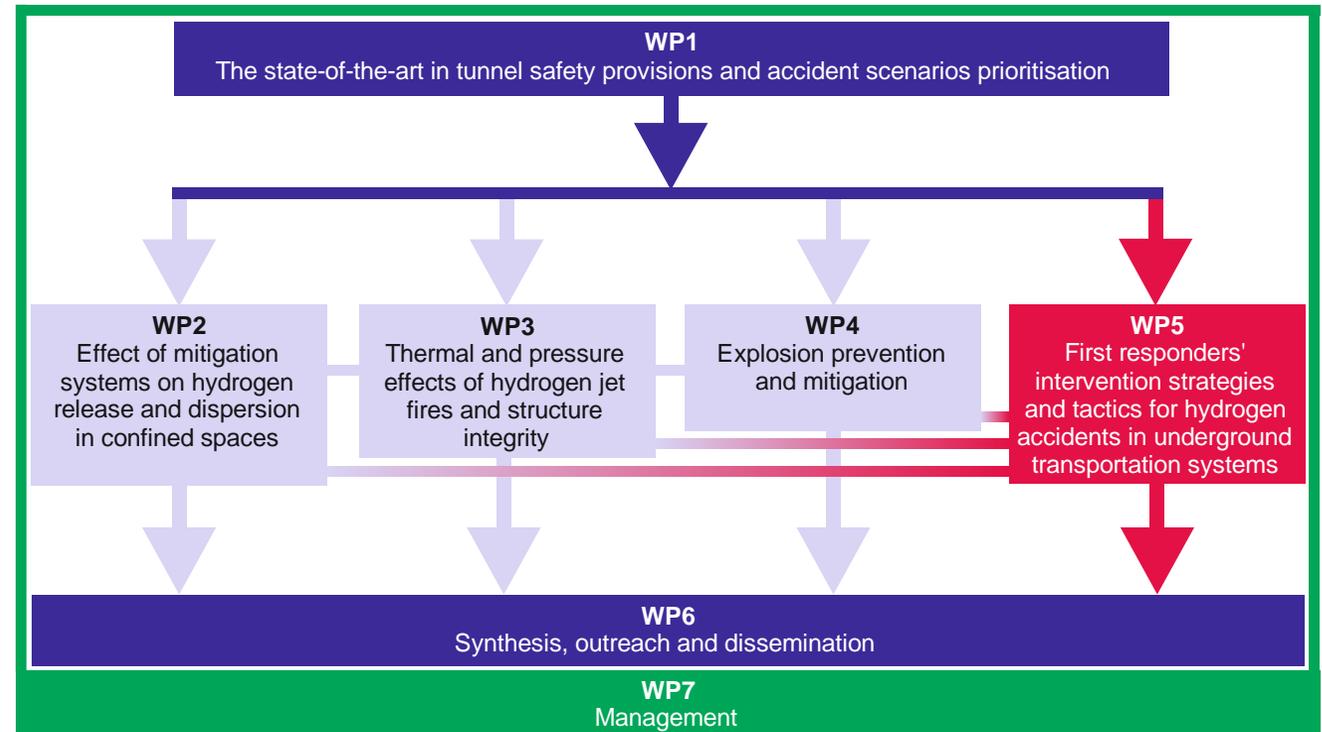
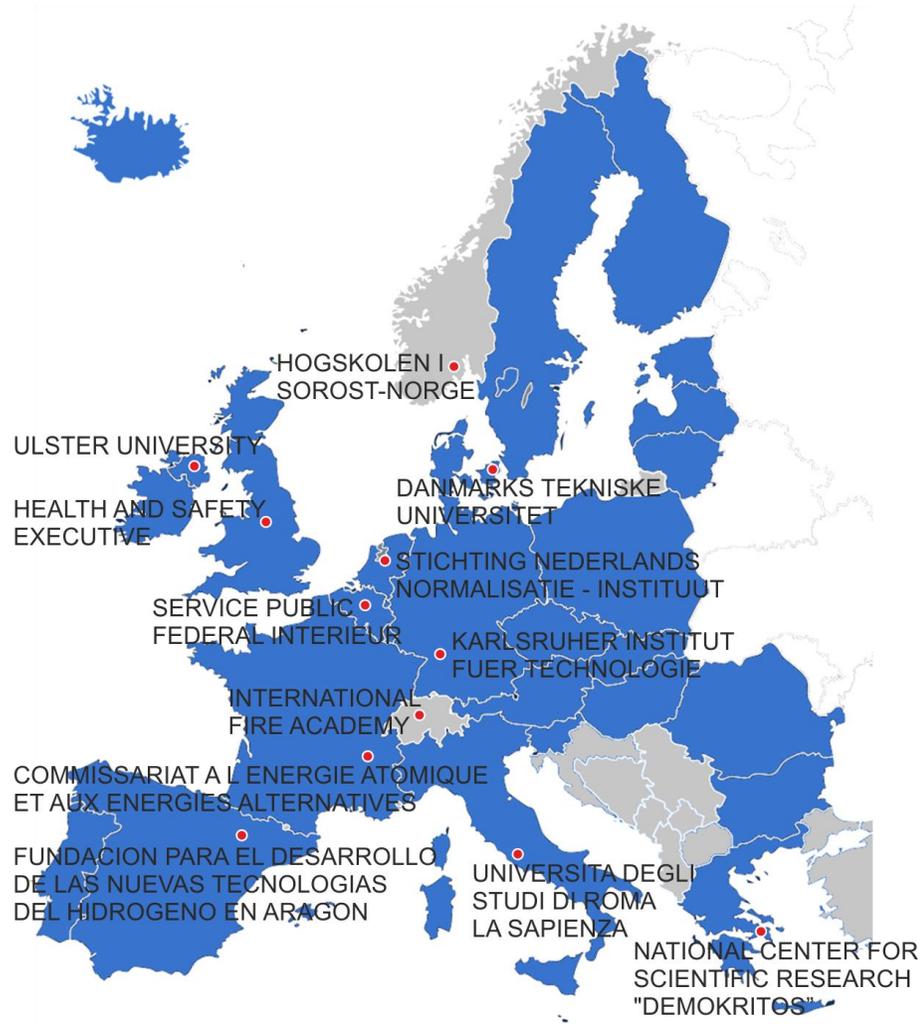
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# HyTunnel-CS project (01.03.19-28.02.22, €2.5M)

Details and public deliverables at <https://hytunnel.net/>

- 13 partners from 11 countries
- Pre-normative research (NEN)
- Work plan (below):



# The intermediate new insights (1/4)

## Unignited release and dispersion:

- We know how hydrogen vehicle can be designed to exclude formation of flammable cloud under the ceiling of tunnel or underground parking.
- We know that slope of tunnel does not affect distribution of hydrogen even for releases from large diameter TPRD.
- We know that to exclude formation of the flammable cloud release downwards allows a larger TPRD diameter compared to TPRD releasing upwards.
- We know that the Pressure Peaking Phenomenon can destroy the garage or maintenance shop and that ignited release (jet fire from TPRD) is more dangerous (thus the TPRD diameter must be calculated based on the assumption of ignited release, i.e. jet fire).

# The intermediate new insights (2/4)

## Jet flames:

- We know that hydrogen jet fire adds from little to nothing to Heat Release Rate of vehicle fire with the decrease of TPRD diameter to fractions of millimetre.
- We know that the Pressure Peaking Phenomenon could destroy residential garage and how to protect structure from demolition (TPRD of fractions of mm).
- We know how release direction affect the TPRD diameter to avoid flammable cloud formation.

## Deflagrations and detonations:

- We know how to prevent large scale deflagrations.
- We know how to assess the possibility of deflagration transition to detonations.
- We know what overpressure can be generated by delayed ignition of highly turbulent under-expanded jet deflagration depending on TPRD diameter and storage pressure.

# The intermediate new insights (3/4)

## Tank rupture in a fire (1/2):

- We know how to exclude tank rupture in gasoline/diesel localised fire (these fires have HRR/A higher than in current fire test protocol).
- We know the mechanism of contribution of hydrogen combustion at contact surface with air into the blast wave strength.
- We know how blast wave after hydrogen tank rupture forms and decays depending on tank volume and pressure, tunnel cross-section area and length.
- We know that consequences of hydrogen tank rupture in a tunnel are unacceptable because it is not possible to mitigate blast wave in tunnels.
- We know how to optimise TPRD-tank system to exclude tank rupture in a fire if TPRD will be initiated within 3 min (not yet solving issue of localised fire).
- We know how to design explosion free in a fire TPRD-less tanks (solving the problem of a localised fire).

# The intermediate new insights (4/4)

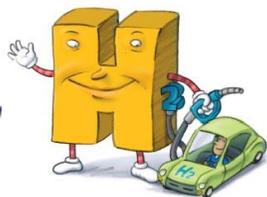
## Tank rupture in a fire (2/2):

- We know that differently from the open atmosphere the fireball propagates very far from the tank rupture location with velocity tens of meters per second.
- We know that the breakthrough safety technology of explosion free in a fire TPRD-less tank will allow avoid devastating consequences of tank rupture:
  - No blast wave
  - No fireball
  - No projectiles
  - No pressure peaking phenomenon
  - No long flames
  - No loss of life and property due to tank rupture
- We know that risk of hydrogen vehicles with explosion free in a fire TPRD-less tank can be below the risk of use fossil fuel vehicles due to exclusion of tank rupture in a fire (still possible that gasoline tank could explode in a fire).

# Worth to enroll

## Acknowledgements to:

- HySAFER Colleagues
- Ulster University
- EPSRC
- FCH JU
- Invest NI
- INTERREG
- Partners



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