

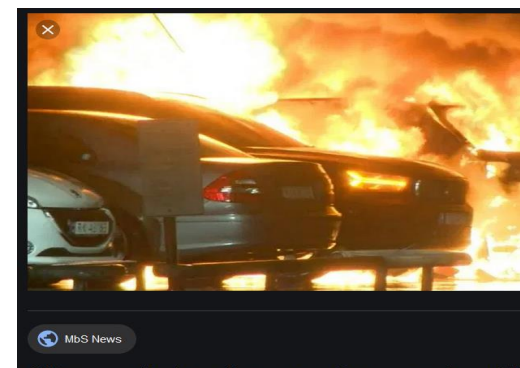


Rijkswaterstaat
Ministry of Infrastructure
and Water Management



Infrastructure perspective

Safety issues FCEV and BEV



Nico van den Berg
ITF Workshop Feb 17th 2020



About RWS

- On behalf [Ministry infrastructure and water management](#)
- [Executive agency](#) for main roads and waterways

Regarding zero emission vehicles and safety

- Service areas
- Department on tunnel safety
- Research, monitor, stimulate cleaner and shifted mobility (clean fuels, car sharing, bicycle use)
- Possibilities for renewable electricity on own areas





Dutch policy developments Zero Emission

National Climate Agreement and related

- Fuel transition outlook (update 2020)
- Factsheets Fuel emissions (update 2020)
- [Battery strategy](#) (in Dutch) following EU developments
- [Hydrogen road map](#); [Innovation road map](#) (in Dutch)

Dedicated to Safety of hydrogen and electric vehicles

- Governmental Hydrogen strategy incl safety chapter (exp 2020)
- Hydrogen Safety and Innovation Platform (kick off Feb 2020)
- Investigation/international inventory parking garage regulation (exp 2020)
- Factsheet electric vehicle safety (update 2020)

Lots of developments right now



Tunnels NL

- 86 tunnels, of which 50 road (24# on main roads, mostly waterway, 3# cat A)
- RWS: expert group, security officer, national standard (links in Dutch: [Exp group](#), [Sec officer](#), [National Standard](#))
- Knowledge expert centres [COB](#), [KPT](#)

Safety organisation and network thoroughly implemented





Road transport of H2 in NL

- Transport on main roads allowed, local regulations may apply
- Yearly evaluation of risks on main roads related to buildings

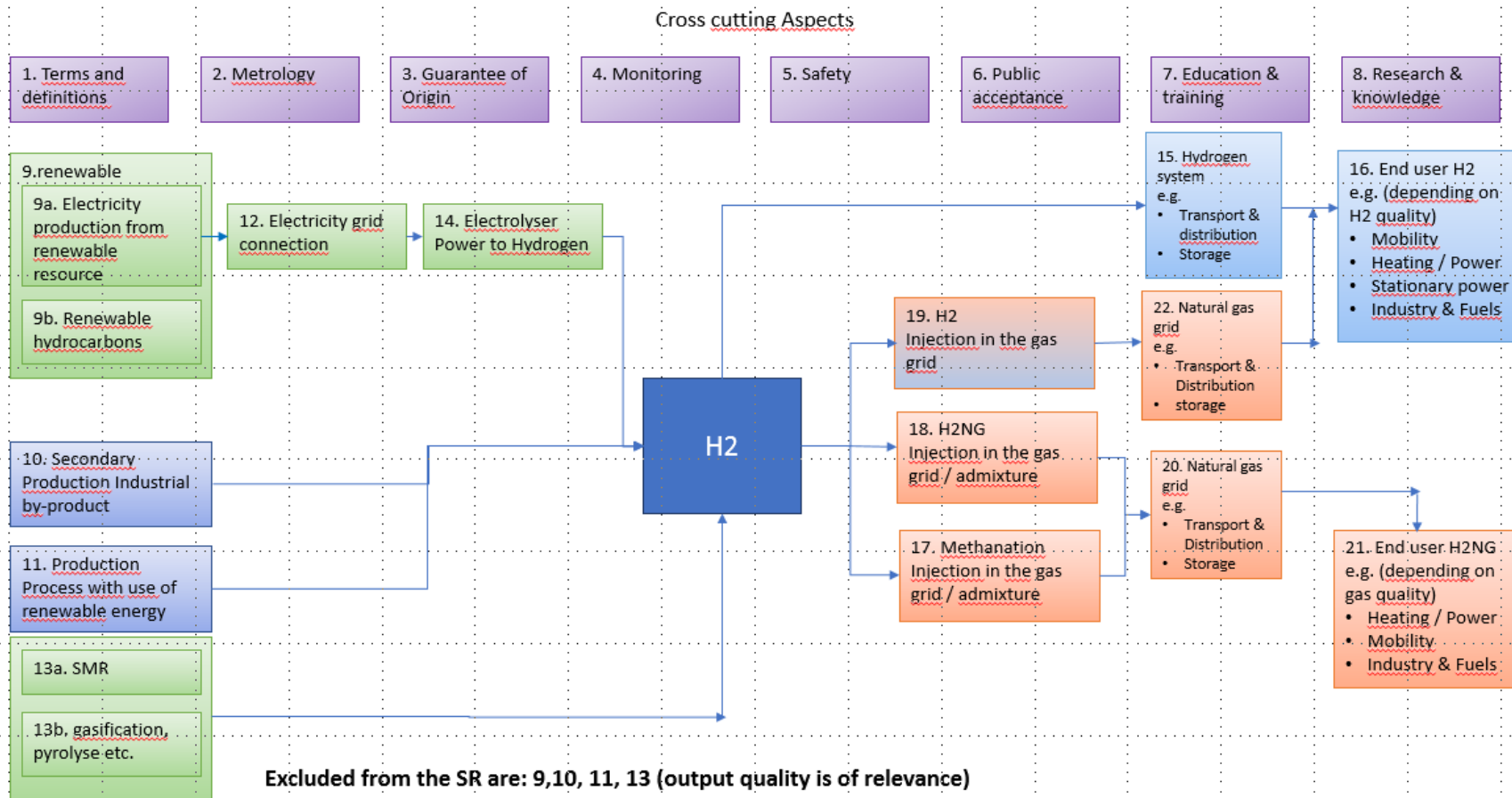
Regulations and evaluation procedures are sufficient





Standardisation at detailed level

Flowchart H2 production → end users



System integration view necessary



Potential safety issues with new energy vehicles

- Generation: Lots of small scale sites expected, electrolysers and possibly methane reformers
- Storage: high pressure equipment
- Road transport: [more tube trailers](#) (English summary) expected
- Refueling/charging: leakage (H₂), high power/thermal runaway (E)
- Vehicle use and parking: confined spaces

Widely spread use of new techniques by less-professionals



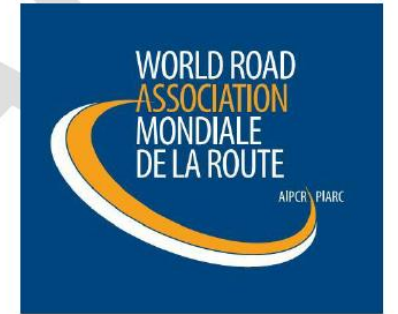
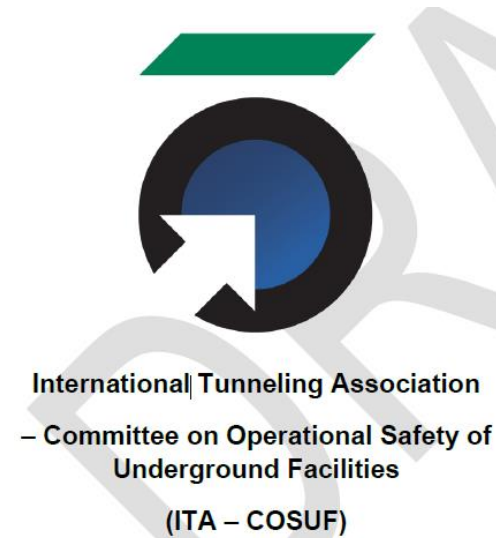
Research need on Confined spaces ...

Ita cosuf draft white paper:

.....the chance to foresee possible risk scenarios and to develop methods and approaches to pro-actively tackle them.

1. accident rates and risks
2. fire development
3. fire fighting
4. additional measures (prevent/prepare)
5. incident management (mitigate, care)

....to be followed by standards development



World Road Association - PIARC



1. accident rates and risks
2. fire development
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Accident rates and risks

- Propulsion restrictions for tunnels or parking garages?
 - [Austria](#) regulates parking of hydrogen vehicles
- Probability of incident start?
 - FCEV/BEV comparable with conventional. [[Rise](#)]
 - parking garages fires [Liverpool](#)/[Stavanger](#) started in conventional cars
- Weaknesses
 - FCEV : leakage (pressure vessels not being inspected!)
 - BEV : thermal runaway / use of non-dedicated connectors

“Issues raise when involved in a fire”

Probability specific weaknesses to be researched



MbS News

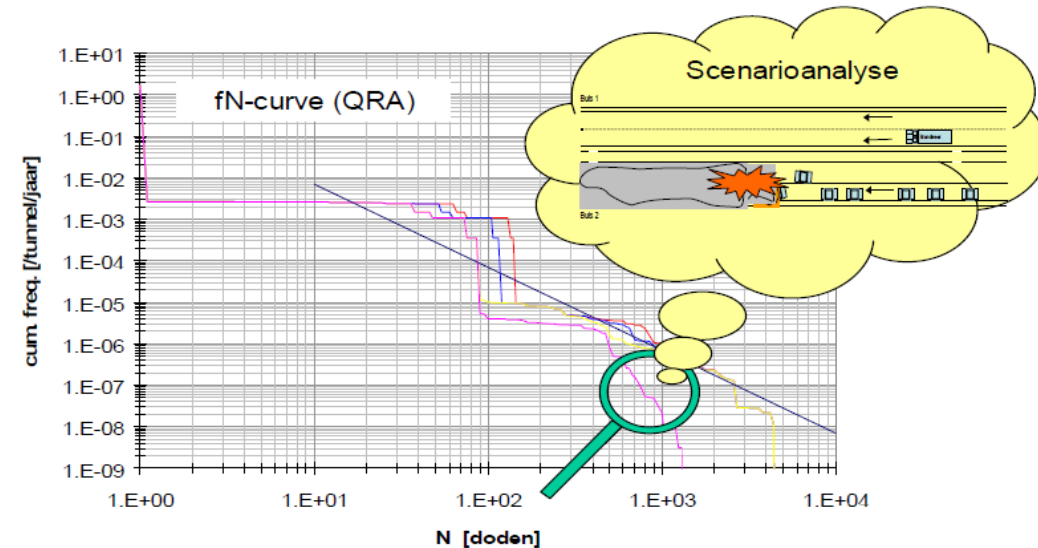
300 cars on fire in parking garage Stavanger airport | M



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Accident rates and risks: tunnels

- EU directives: [Tunnel 2004/54](#) and [Safety management 2008/96](#), see also [Evaluation report](#)
- Risk assessment [models](#) and [software](#) impact probability chart
 - heavy duty H2 vehicles to be included
 - users, vehicles, facilities, traffic, infrastructure
 - scenario's to be elaborated: traffic increase and collision failure, explosion probability, overpressure/broken windows



Regulation exists, further examination necessary due to expected grow H2 heavy duty vehicles



Fire development

1. accident rates and risks
2. fire development
3. fire fighting
4. additional measures
5. incident management

- [Hytunnel-CS 2019–2022](#), pre-normative research safety hydrogen vehicles and transport through tunnels and similar confined spaces
- [Sandia 2017: HFCEV Tunnel safety Study](#)
- Inventory known research by IPHE-RCSS/Hysafe/Sandia (exp 2020)

Physics research still ongoing

Figure 14. Hydrogen concentration at $t=3$ s contours through the plane parallel to the tunnel axis (Bie & Hao, 2017).

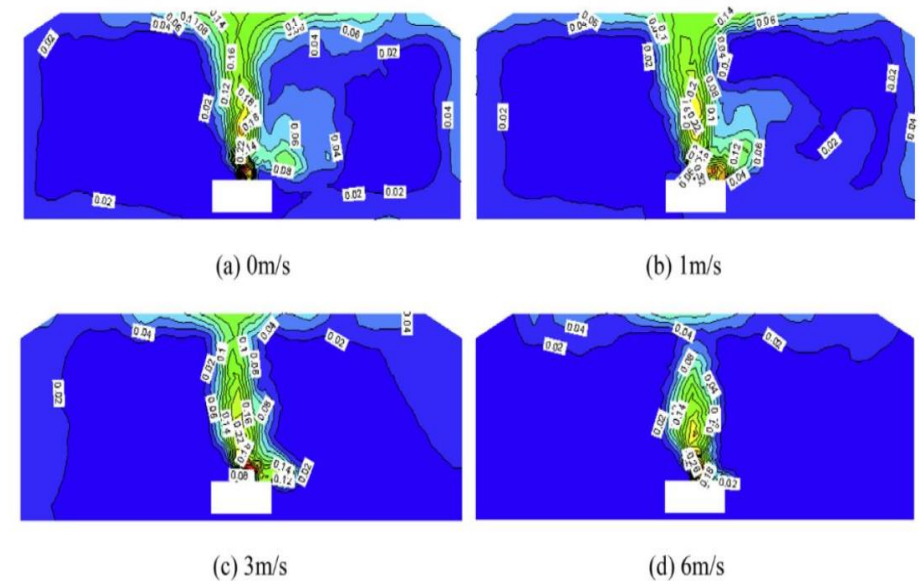


Figure 15. Hydrogen concentration at $t=3$ s contours through the plane perpendicular to the tunnel axis (Bie & Hao, 2017).



1. accident rates and risks

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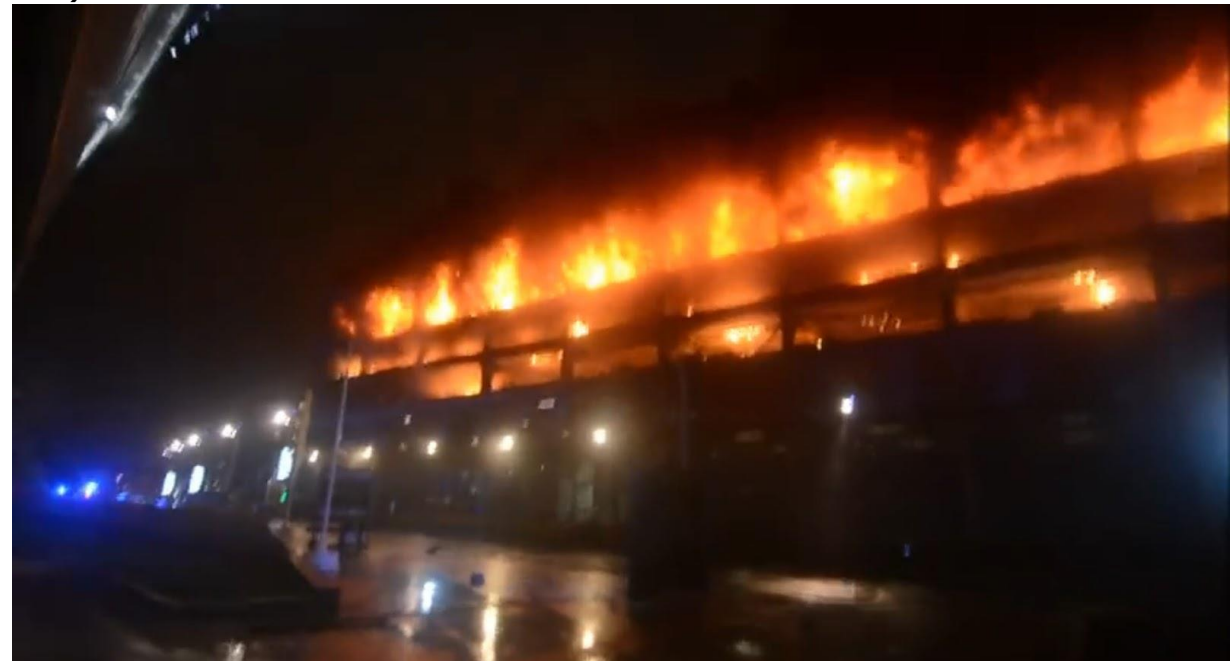
Fire development

- E: thermal runaway -> toxic smoke, battery difficult to extinguish
- H2: leakage -> gas cloud explosion
vessel release -> jet flame

Questions

- Combination: Fuels together with batteries, hydrogen and?
- H2 outflow Thermal Pressure Release Device
(location nor direction regulated, addressed in [research call](#))
- Does Hydrogen vessel follow standard test?
(rupture when Thermal Pressure Release fails)
- Battery difficult to extinguish due to insulation?

Questions about propagation





1. accident rates and risks
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Fire fighting in parking garages or tunnels

- Detailed [CTIF guide](#) on new energy vehicles, some attention to confined spaces
- H2: [European Response Guide](#) and [US training set](#) do not specify confined spaces
- [Crash Recovery System](#) needs identifiable license plate
- [CTIF-ISO 17840](#) about marking, response guide, vehicle fuel symbols
- [Swedish handbook](#) includes procedures gas-powered cars at indoor and outdoor incident sites
- ITA COSUF: expose fire fighters? Awareness? Corrosive substances? Additional reactions extinguishing agents? Tackle explosion? Water to cool battery fires?
- [IFV](#): regarding new fuels, NL not prepared anything yet for tunnels



“Internal extinguishing operation only in order to save lives, external fire suppression preferable”

Fire fighting approaches for confined spaces to be reviewed



1. accident rates and risks
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Additional measures necessary?

- NL: Systematical scenario analysis
(in Dutch: [procedure](#), [paper](#), [evaluation](#))
- Measures suggested in literature
 - Marking of vehicles
 - Modifications fixed-firefighting-system
 - Detection
- Rethink operation of underground facilities?

Evaluation procedures exist, new energy to be included





Incident management

1. accident rates and risks
2. fire development
3. fire fighting
4. additional measures
5. incident management

- NL: tailor made procedures tunnel management for pilot project (4 Hydrogen range extender buses, exp 2020)
- Additional suggestions in literature:
 - Quick evacuation
 - Enhanced or automated traffic management
 - Instructions for drivers and passengers

**New energy concepts to be included,
Lessons from pilots expected**





Observations infra aspects new energy vehicles

- Main safety issues road infrastructure relate to confined spaces
- Currently moderate risk, due to low probability but vehicle amounts will grow
- Knowledge and procedures exist ...
... and research is being conducted ...
... but has not been finished ...
... and will need further implementation



Thank you for your attention

For further reading (not linked before)

- [IPHE RCSS](#) started an inventory on Regulation, Codes & Standards, identifying gaps for action
- [HyLaw](#) European database on regulations and barriers, finished
- [ITA COSUF](#) NEC workshop [proceedings](#); White paper in progress
- CEN/CENELEC Sector Forum Energy Management [2018 report](#)
- [CEN/CENELEC: JTC6](#) (Hydrogen in energy systems)
- [FCH2JU Regulations, Codes and Standards Strategy Coordination Group](#)
- Tunnel Events: [ISTSS, March 2020, Munich](#) and [FIVE, October 2020, Amsterdam](#)
- Incident databases: [Hiad](#), [H2tools](#)
- IEA technology collaboration programme [Hydrogen task 37](#)
- [IRCC](#) experts on building regulation
- Exchange of experts on green vehicles May 2019, [IFV Arnhem](#)
- Contacts Netherlands: [WVIP](#) (in Dutch), [FET](#), [IFV](#),