BAM
Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

CHALLENGES FOR HYDROGEN TECHNOLOGIES

ACTIVITIES OF H2SAFETY@BAM

www.bam.de

H_2Safety@BAM

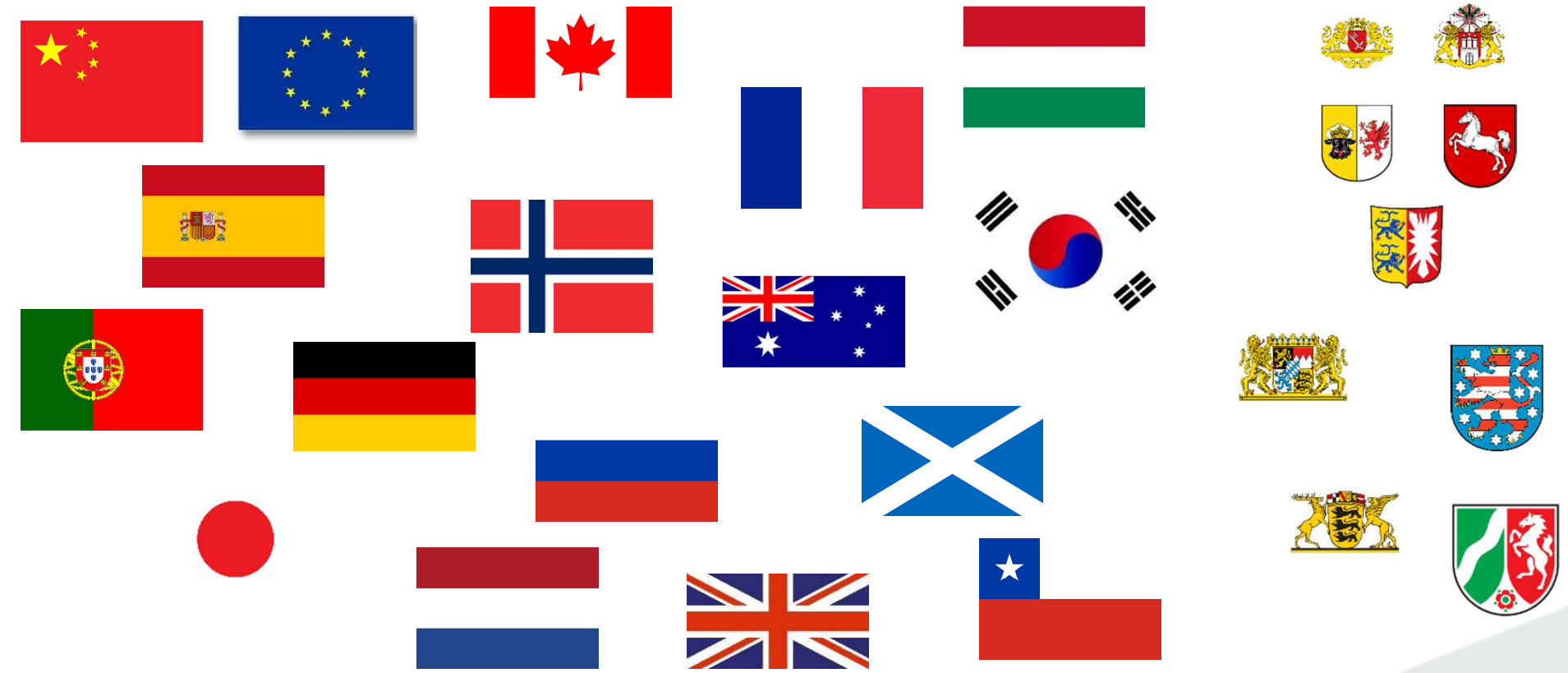
The Hydrogen Value Chain

Source: HyPos

Central Benefits of a Hydrogen Economy:

- System Integration
- Storage & Transport Capabilities
- Sector Coupling

Hydrogen Strategies



Hydrogen strategies of countries and regions published between 2019 – 2021 (Japan 2017, Source: VDMA)

The German National Hydrogen Strategy – On Infrastructure

"A safe and reliable supply of hydrogen that meets the demand and is efficient overall will be central to the hydrogen market in the future. To this end, the potential of existing infrastructures - where needed - will be utilized wherever possible and, if necessary, the development of new supply structures will be initiated."

3 of 38 action items are defined to directly address the infrastructure.

Competence centre H_2Safety@BAM

Our contribution to the national a European hydrogen strategy

BAM´s Hydrogen-Strategy: with the competence center H_2Safety@BAM we identify safety requirements for the successful use of hydrogen technologies at national and European level …

- which is a basic condition concerning H2-readiness and the successful market ramp-up of hydrogen technologies
- through promoting and developing reliable quality and safety standards as a clear advantage for companies to enter the market
- to ensure acceptance of the new technologies

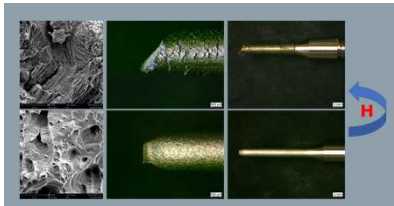
We build trust in hydrogen technologies!

Safety makes markets!

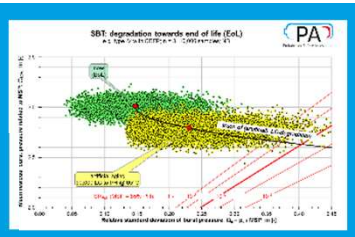
September 2020

Competence centre H_2Safety@BAM

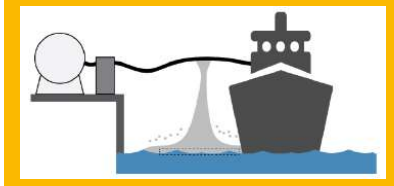
Five competence areas

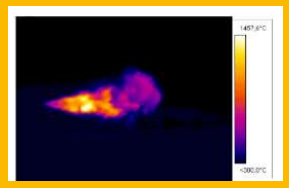


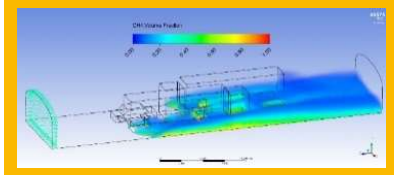
MatCom: Material properties and compatibility



TestCert: Component testing, safety and certification







ProSafe: Safety of processes and systems

SensRef: Sensor technology, analytics and certified reference materials

Cross Cutting Topics

Specific as well as interdisciplinary scientific and safety-related topics are investigated at BAM by experts from atomic scale to the operation of systems at real scale/under real conditions.

Forschungsnetzwerk Wasserstoff – Expert Opinion on Safety Related Needs

Leakage monitoring:
Innovative methods for zum domain monitoring, Sensor concepts

Material compatibility:
guidelines for the safe selection of suitable materials; Development of test methods

Behavior of H2 in accident scenarios:
Improve of understanding of scenarios
to support the development of RCS

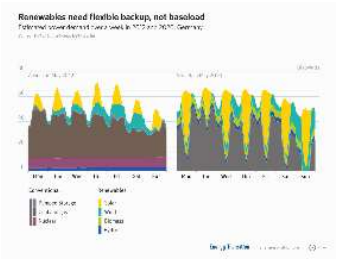
Safety concepts:
Guidelines for specific protective measures

Additive Manufacturing:
Use of additive manufacturing technologies
for components

Challenges for Hydrogen-Technologies

Upscaling

Quelle: BMBF



Operating conditions (dynamic, pressure etc.)

„Non-industrial" environment

Costs

Hydrogen Transport in Pipelines

Source: PP-Engineering

"Hydrogen pipelines are the most cost-efficient option for long-distance, high volume transport of hydrogen to connect hydrogen supply regions with demand clusters within the EU+ UK." *(European Hydrogen Backbone - Analysing future demand, supply, and transport of hydrogen, Guidehouse, 2021)*

"Hydrogen trade will be regional: shipping hydrogen is more expensive than pipes or cables" *(Agora Energiewende, Agora Industry (2021): 12 Insights on Hydrogen)*

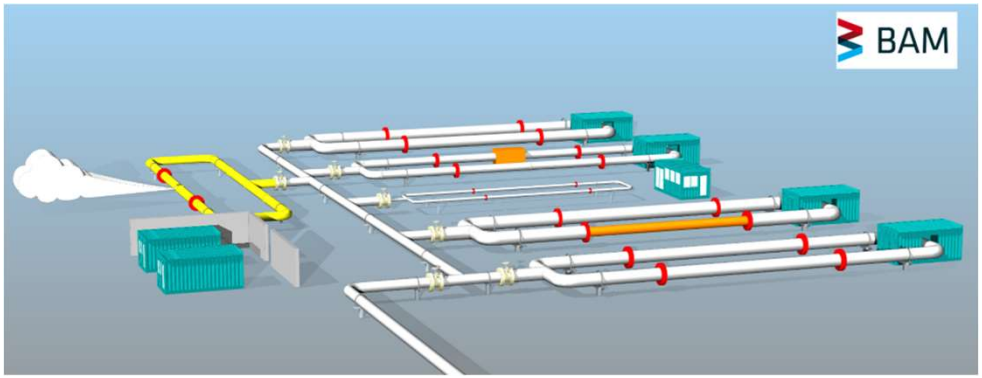
Evaluation of Material Compatibility: Due to its high diffusivity compared with natural gas hydrogen can permeate easily solid materials potentially causing material degradation (e.g. hydrogen assisted cracking of metals or degradation of gasketing materials).

- Which pipeline materials can be used for hydrogen and how can the materials be evaluated concerning hydrogen suitability?

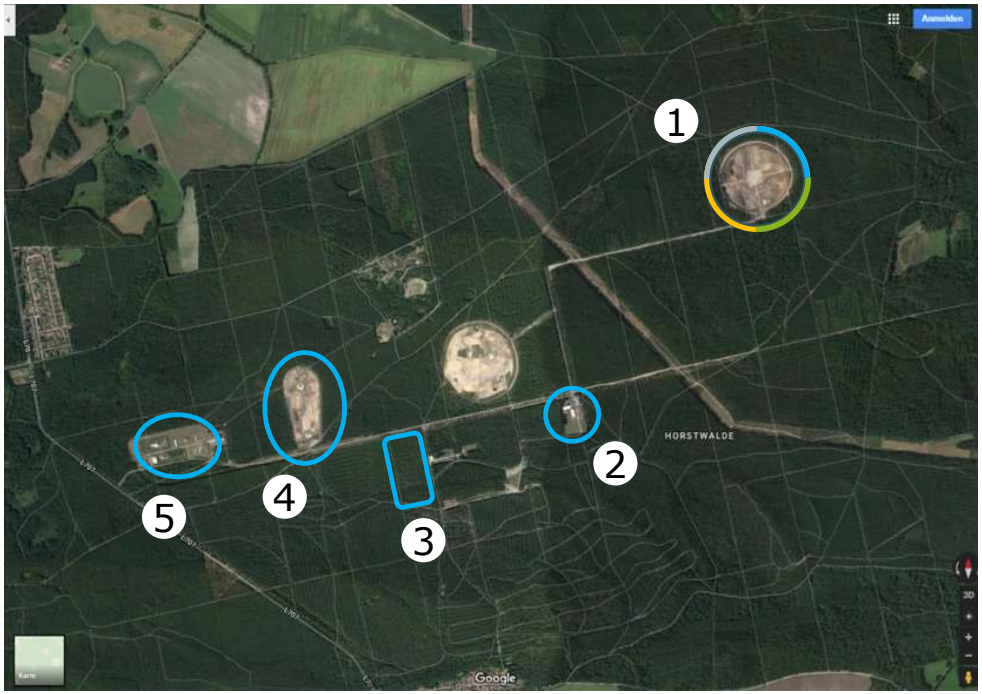
Gas Quality: Using the existing natural gas grid for hydrogen transport, impurities must be considered.

- What is the influence on the gas quality and how can the gas quality be monitored?

Project ModuH2Pipe - Modular test platform for hydrogen pipelines



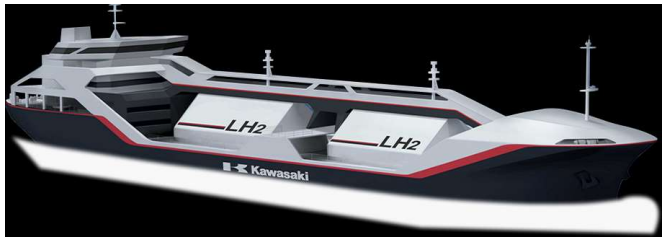
- Modular test platform for real-scale safety related investigations in context with hydrogen pipelines
- Considering component safety, material compatibility, online- analytics
- Including loops for tests outside normal operation up to critical operating conditions (e.g. destructive testing)



TTS: Test Areal „Hydrogen Safety" offers unique testing possibilities

Transport of Liquid Hydrogen (LH2)

2020/2022: 2500 m³



https://global.kawasaki.com/en/stories/articles/vol18/

https://energyresearch.ucf.edu/research/hydrogen/liquid-hydrogen-storage/

Future: 160.000 m³

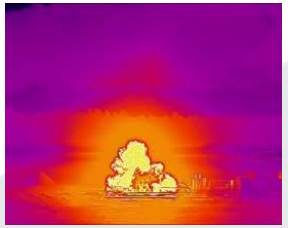
https://wiki.openstreetmap.org/wiki/File:Berlin-WasserstoffTankstelle-2007.jpg

- LH2 provides larger densities and gains in efficiency over gaseous transport and storage.
- Scale-up must be addressed
- The hazards and risks associated with LH2 are different from the relatively well-known compressed gaseous hydrogen (e.g. dispersion & mixing phenomena, ignition behavior on solid or liquid ground, liquification of air, evaluation of accident scenarios)

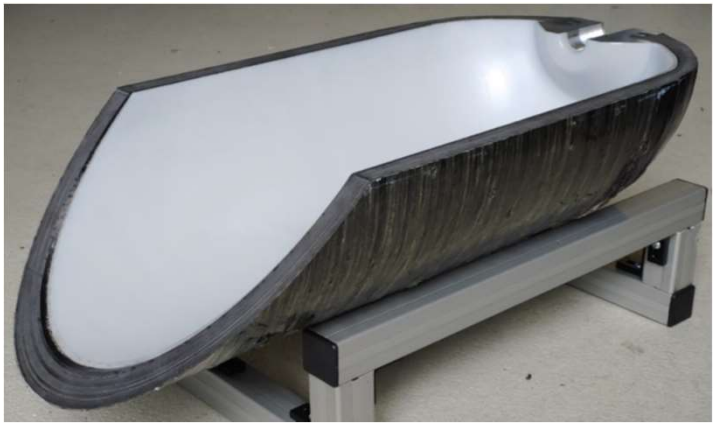
Project: Safety related research in the field of LH2 storage and transport applications

Part 1: BLEVE Tests

Part 2: RPT Tests

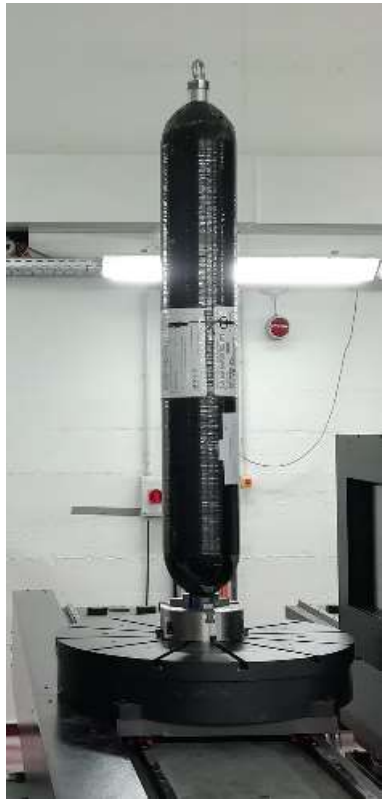


Mobile Use of Hydrogen



Section of a type IV cylinder for 700 bar

Trade-Off:
Costs vs. Safety



material costs	70%
+	+
litigation costs	28%
+	+
markups	2%
=	=
overall costs	**100%**

Project: DELFIN
High energy impact Testing up to 25kJ@70MPa

Research into alternative materials and manufacturing processes for cost- and weight-reduced pressure vessels made from continuous fibre-reinforced plastic

construction of the impact test bench with internal pressure (modular drop apparatus)

implementation of a splinter protection; Patenting of modular anti-splinter elements

implementation of a gas filling unit for filling with hydrogen (gas weighing unit)


Competence centre
H2Safety@BAM
We build trust in hydrogen technologies.
Contact:
Dr.-Ing. Enis Askar
Phone: +49 30 8104-4435
Email: enis.askar@bam.de