



## **HyProvide Workshop om brintsikkerhed Internationale erfaringer** Regulering & best practices herunder forskning i brintsikkerhed: IA HySafe

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Partnerskabet for brint og brændselsceller

# HyProvide Workshop om brintsikkerhed

## Internationale erfaringer

regulering & best practices

herunder forskning i brintsikkerhed: IA HySafe

**Frank Markert**

DTU Management Engineering

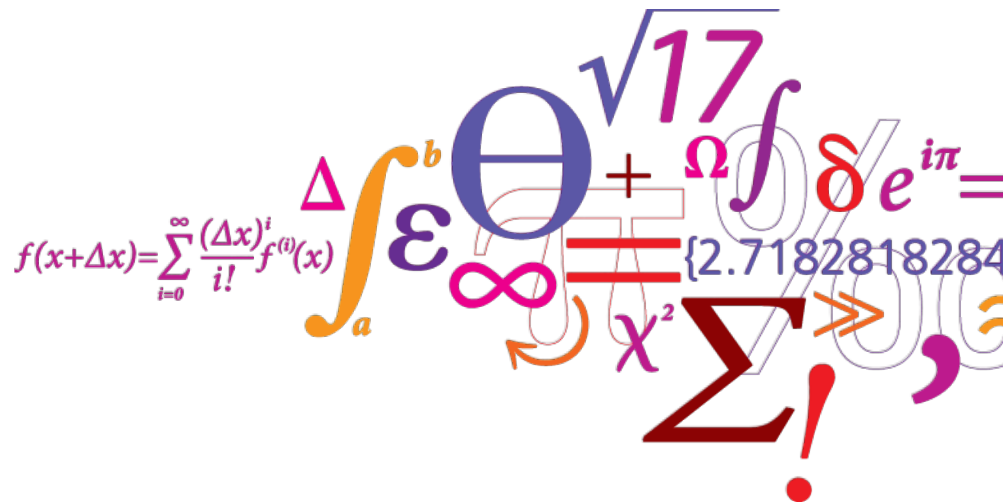
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**DTU Management**

Institut for Planlægning, Innovation og Ledelse

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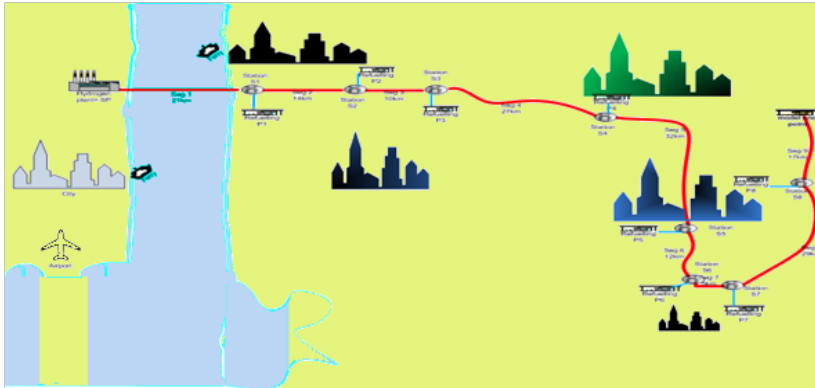
# Produktion Service Management

## RISK RESEARCH group

- Industriel sikkerhed
- Kvantitative og kvalitative metoder :
  - Fare identifikation
  - Scenario analyser
  - Konsekvensmodeller
  - Risikovurdering
  - Risikoevaluering
- Metoder anvendes til undersøgelse af brintsystemer
  - RHS – tankstationer
  - Produktion
  - Lagring
  - Transport

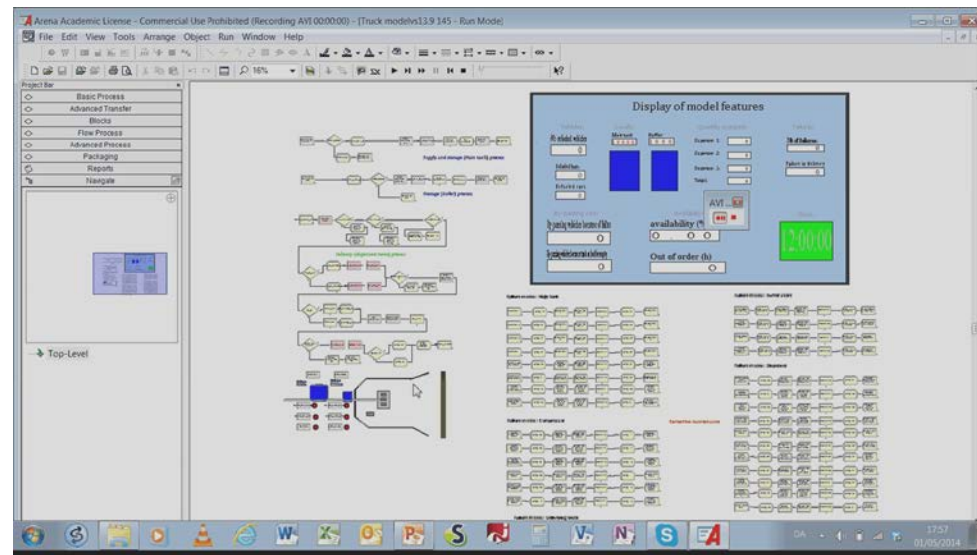
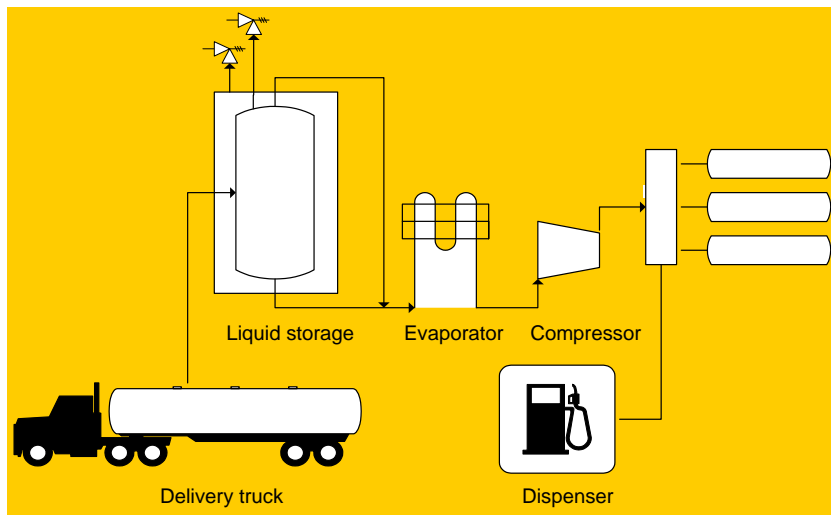
# FORSKNINGSTEMA: BRINT SUPPLY-CHAIN

Formål: Hvordan sikres uafbrudt brint supply og minimer lagring af brint for øget indernt sikkerhed.



## Brint tankstation model – master projekt:

- Brint forsyning
- Lagringsfacilliteter
- Dispensers til
- Cash desk
- Failure modes



# Resultater fra simuleringen

**Modellen kan mængden af brinten der tankes forudsige inkl. Down times og mangel på brint ved fejllieferinger**

- Modellen kan reproducere data fra et EU brintstation
- Inherent sikkerhed:
  - Den beregnede maks. Kapacitet på HRS er 990 kg brint per dag under antagelse af 112 køretøjer per 24 timer
  - Køretøjer er 100 biler (4,5 kg H<sub>2</sub>) og 12 busser (45 kg H<sub>2</sub>)
- 
- Den gennemsnitlige beregnede kapacitet er  $934 \pm 9$  kg (flere simuleringer)

**Modellen kan anvendes for mere komplekse situationer (antal og typer af køretøjer) variationer ifm. årstiderne etc.**

# Produktion Service Management

## RISK RESEARCH group

- Industriel sikkerhed
- Kvantitative og kvalitative metoder :
  - Fare identifikation
  - Scenario analyser
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  - Risikoevaluering
- Metoder anvendes til undersøgelse af brintsystemer
  - RHS – tankstationer
  - Transport
  - IA HySafe

# Vision and Mission



## Vision

Hydrogen will be introduced as a safe and sustainable energy carrier.

## Mission

To facilitate the international coordination, development and dissemination of hydrogen safety knowledge by being the focal point for hydrogen safety research, education and training.



# HySafe Basics



**Founded in 2009**

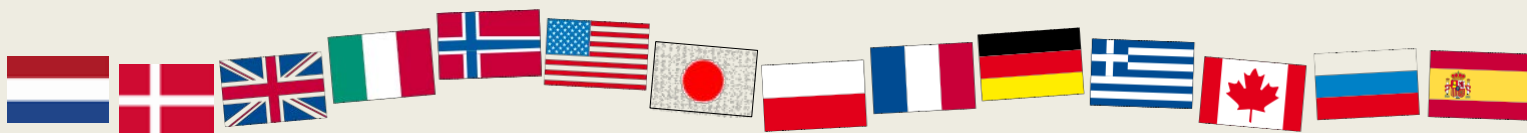
**Legally: international non-profit association under Belgian law with legal address in Brussels.**

**33 members: public institutions, national labs, universities and private companies.**

**24 from Europe, 8 from North America and 1 from Japan.**



**GA 2012, Berlin**





# International Conference on Hydrogen Safety (ICHS)



## Participants of ICHS2013

2005 – Pisa, Italy

2007 – San Sebastian, Spain

2009 – Ajaccio, France

2011 – San Francisco, USA

2013 – Brussels, Belgium

2015 – Tokyo, Japan



# Education and Knowledge Dissemination



Toronto 2012



San Francisco 2011

Safety related workshops and professional training courses

Financial and other support for university curricula with relevant topics including MSc in hydrogen safety engineering

In-house courses for interested parties

Berlin 2012



# Research Priorities Coordination



The Association facilitates the networking for the development and dissemination of knowledge and for the coordination of research activities in the field of hydrogen safety.

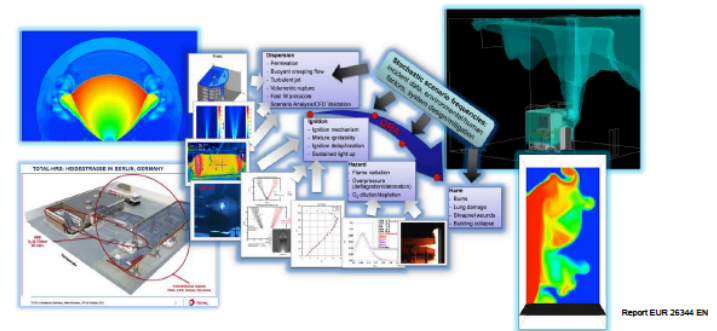
Based on its leading position in hydrogen safety research and development, HySafe facilitates assessment of the state of-the-art in hydrogen safety and identifies priorities for further research as input to strategic agenda of H<sub>2</sub> research and innovation programs worldwide.

JRC SCIENCE AND POLICY REPORTS

## STATE OF THE ART AND RESEARCH PRIORITIES IN HYDROGEN SAFETY

Alexei Kotchourko, Daniele Baraldi, Pierre Bénard, Norbert Eisenreich, Thomas Jordan, Jay Keller, Armin Kessler, Jeff LaChance, Vladimir Molkov, Mark Steen, Andrei Tchouvelev, Jennifer Wen

2014



Report EUR 26344 EN

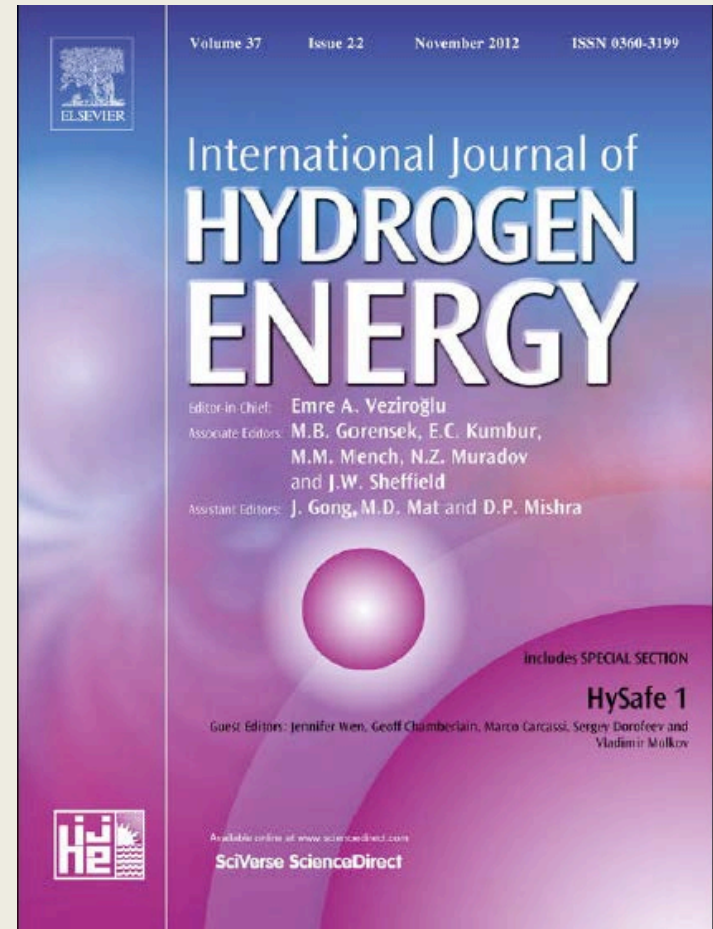
Joint  
Research  
Centre

# International Journal of Hydrogen Energy



**Published a number of special issues: 3 issues between ICHS2011 and ICHS2013**

**All best ICHS papers are published in IJHE special issues**



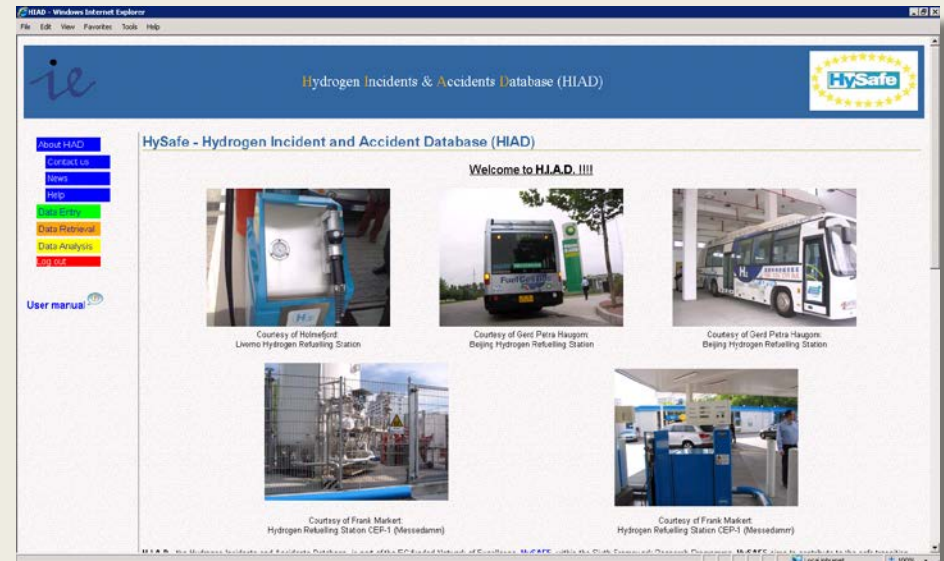
# Addressing Industry Needs

INTERNATIONAL ASSOCIATION  
FOR HYDROGEN SAFETY

Hydrogen is now leaving the demonstration phase and transitioning to the commercialization phase

Industry related topics:  
composite cylinders, fast filling,  
effect of H<sub>2</sub> on metals, H<sub>2</sub>  
indoors and in enclosures, risk-  
informed safety distances

Accident / incident databases  
and lessons learned: HIAD, EIGA,  
collaboration with  
H2incidents.org



# HySafe and Standards



**Consistent safe and reliable performance needs regulations, codes and standards.**

**Practical standards can only be developed on the basis of reliable information, knowledge and expertise.**

**HySafe is the source of these attributes.**

**ISO TCs participation: 197 (Hydrogen Technologies) Cat A liaison, 220 (Cryogenic Vessels), 58 (Gas Cylinders)**

**By sending experts to the working groups and providing other forms of input at the TC level, HySafe is able to contribute an important element to the work program of the ISO/TC197.**

# HySafe Contacts



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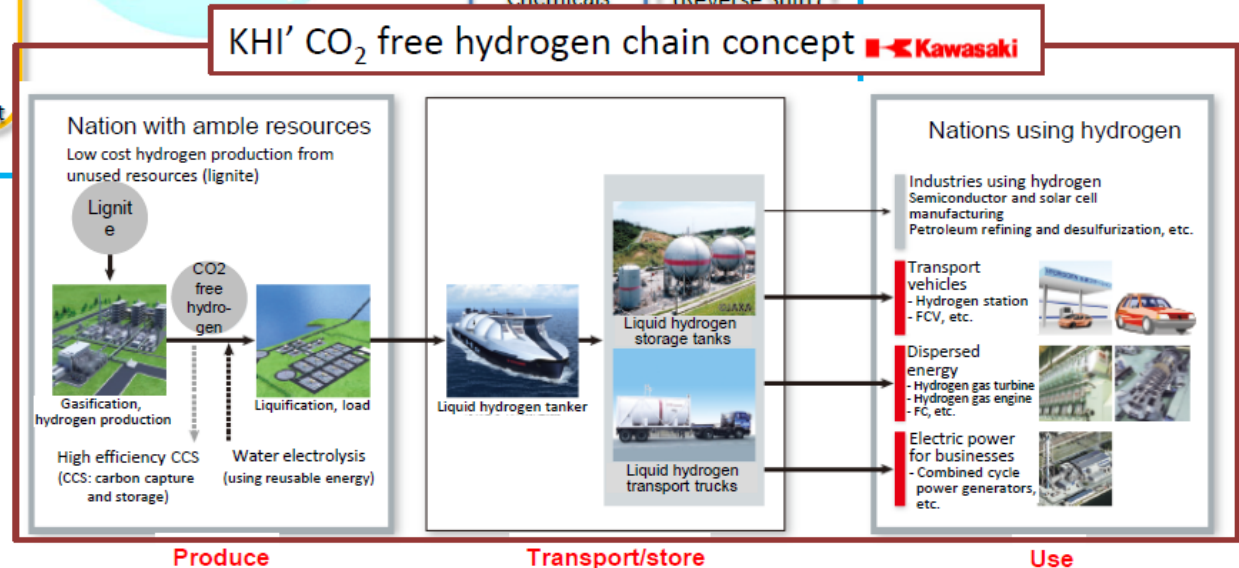
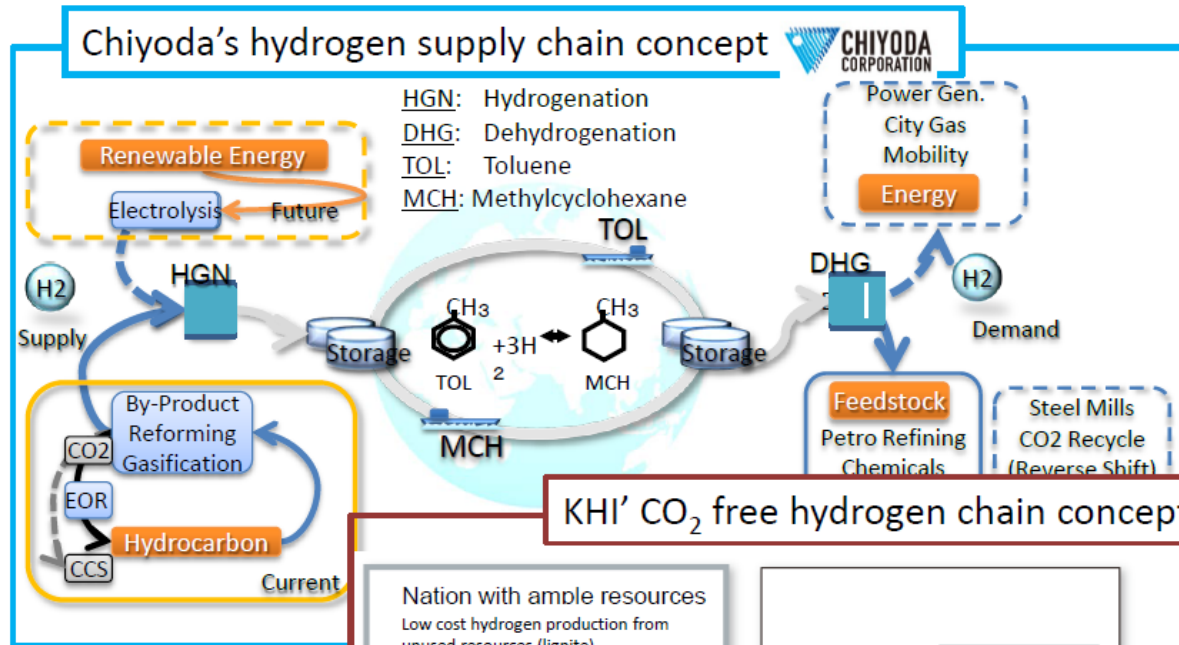
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*[fram@dtu.dk](mailto:fram@dtu.dk)*



# Visioner for brintinfarstrukturur

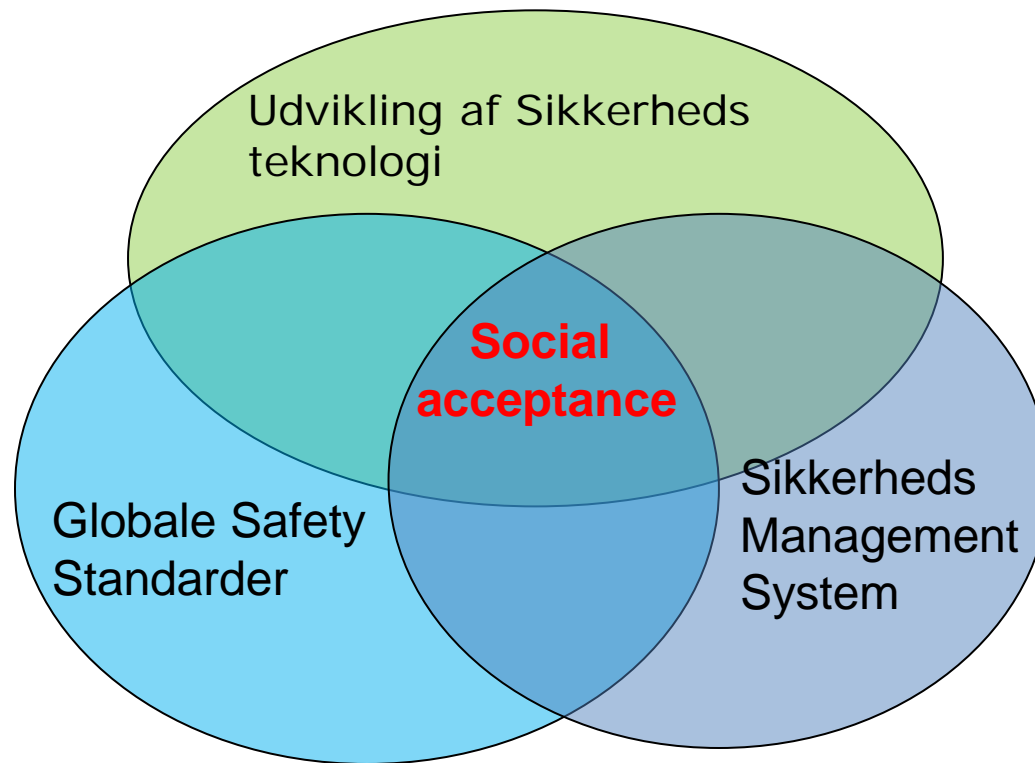
## f.eks. Japan



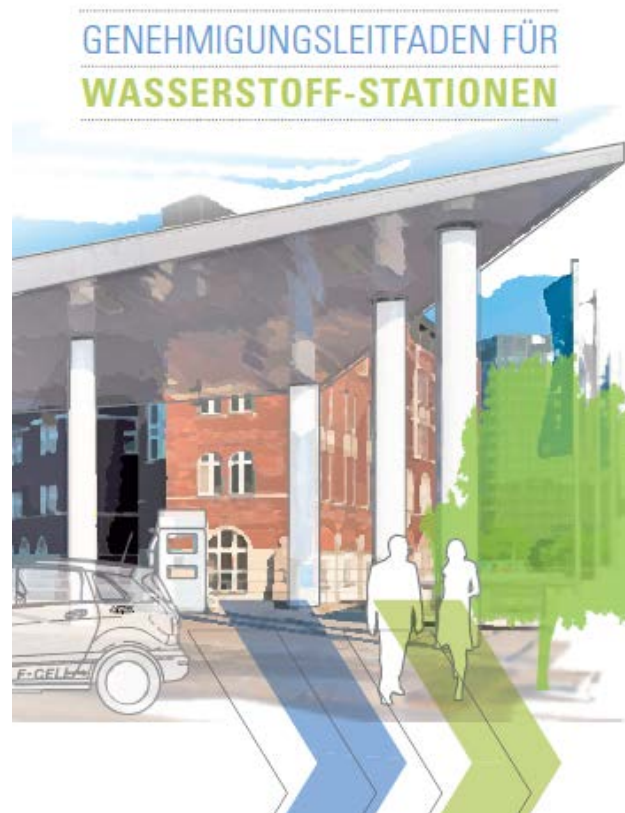
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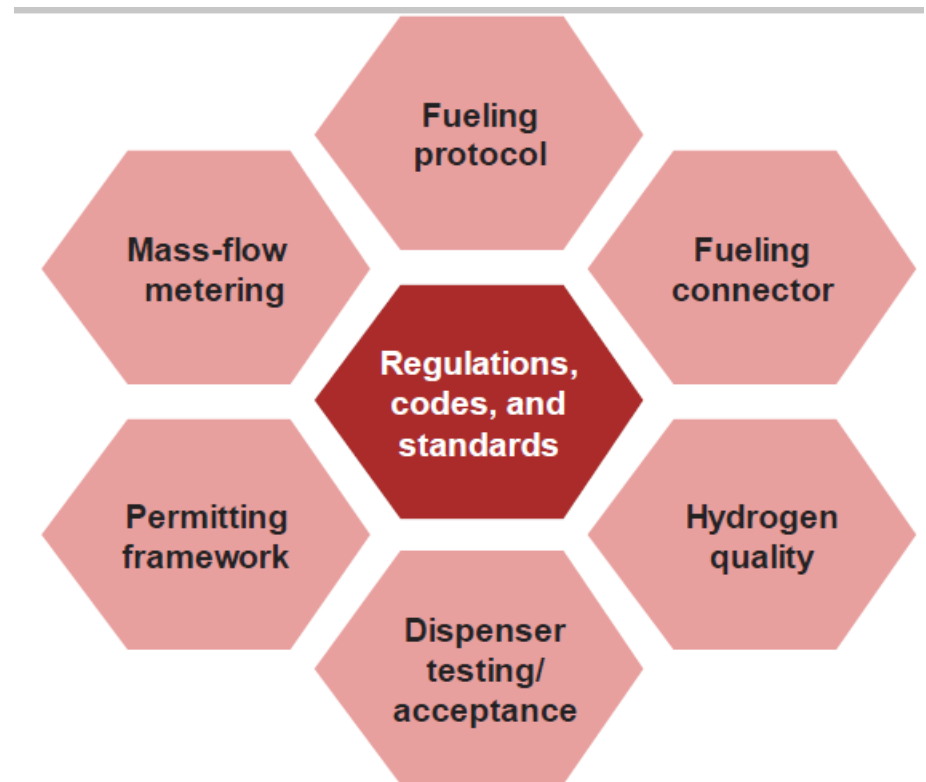
# Social acceptance



# Regulering i Tyskland

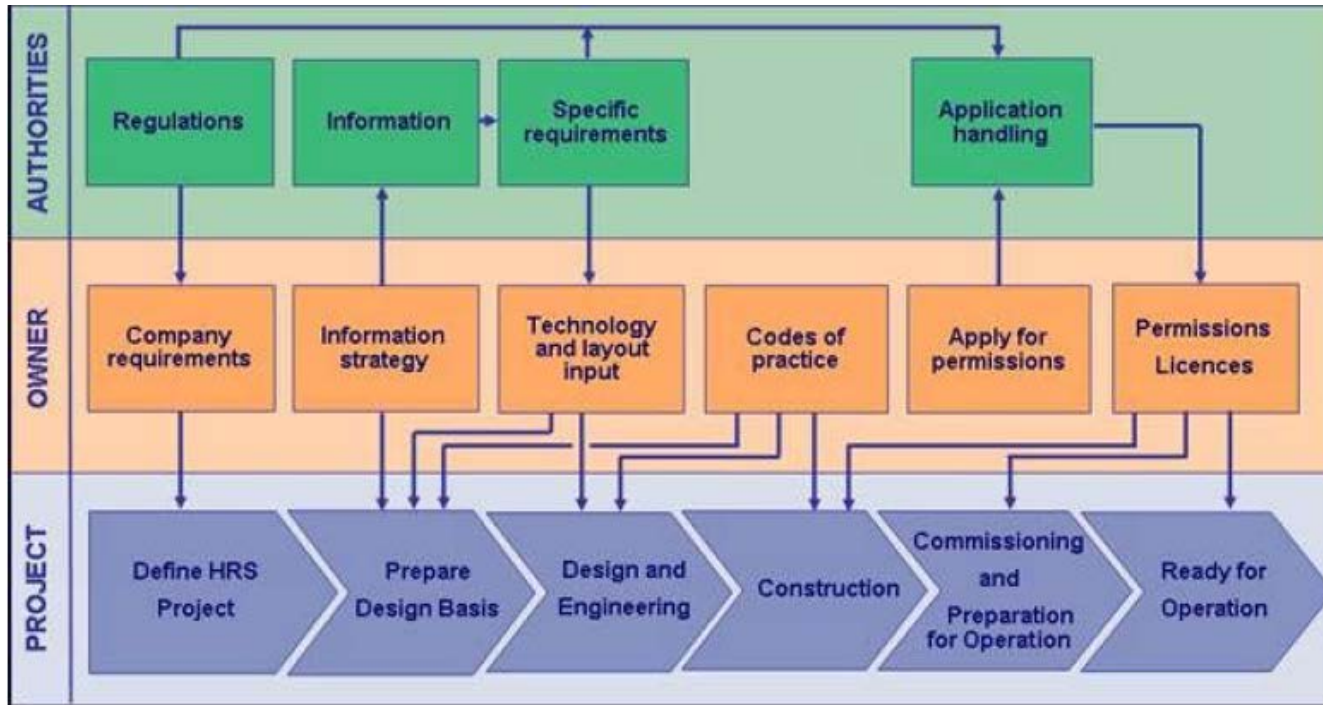


International samarbejde på RCS udvikling er nødvendigt



Lit.: ICHS 5 sept 2013 Torsten Herbert

# Forslag til godkendelsesprocedure



SICHERE WASSERSTOFFINFRASTRUKTUR

ENDBERICHT

Im Auftrag des



Bundesministerium  
für Verkehr, Bau  
und Stadtentwicklung

vertreten durch

**NOW**

Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

Lit. Rapport Sicure Wasserstoffinfrastruktur Endbericht 9.  
Dezember 2011

# Erfaringer fra Tyskland

- Brint er nyt teknologi også for myndighederne
- Vejledninger og (jurid. bindende) forskrifter mangler endnu
- Godkendelse af tankstationer på regional niveau (tyskland og østrig) . Hvem er ansvarlig? NOW har en web side for det.
- Vigtig med tidlige og regelmæssige kontakter til relevante myndigheder i alle projektfaser
  
- Lovgivning f.eks.:
  - Seveso II regler gælder fra  $H_2 > 3t$ ,
    - hvis ikke tidsbegrænset  $< 12$  måneder og
    - ikke forsknings, opskalerings facilitet

# Erfaringer fra Northern California's first 70MPa HRS

## Lessons learned vedr. godkendelse, konstruktion og operation:

1. Grundig initierende planlægning er et must for en glidende projektfremgang
2. Godkendelse er en milepæl og tidlig kontakt med lokale myndigheder er kritisk
3. Omfattende sikkerhedsrapporter kan være nødvendigt, som øger projektomkostninger og kompleksitet
4. Udfør arbejde på byggepladsen omhyggelig planlagt og udført
5. Metodisk I driftsætning af systemet og komponenterne er en milepæl
6. Omhyggelig vedligehold og operations planlægning er kritisk for at minimere "station downtimes"
7. Lit.: Lipman et al. IJHE 38 (2013) 15868

**Mange tak for i dag**

fram@dtu.dk