



# HySafe

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## Safety Issues and Safety Action Plan

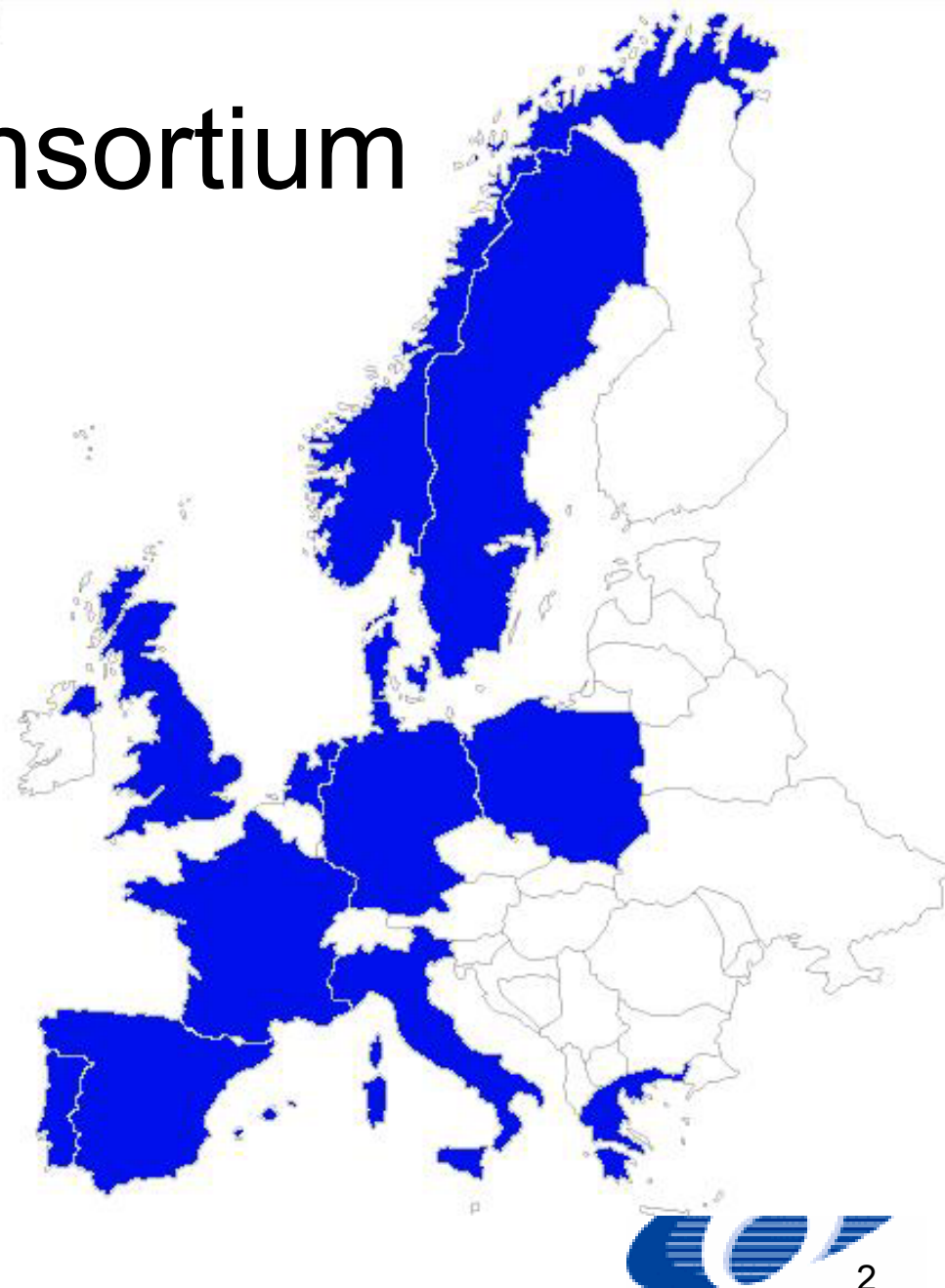
Thomas Jordan








Representative of the HySafe co-ordinator  
Forschungszentrum Karlsruhe GmbH

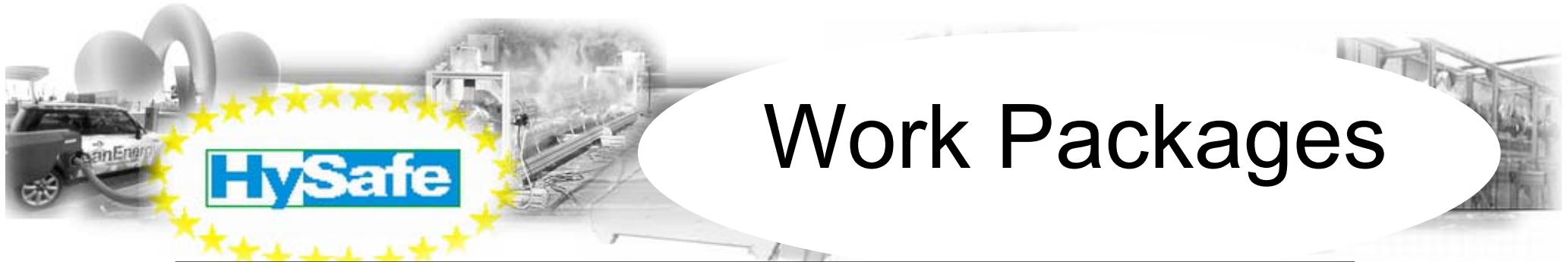


EUROPE

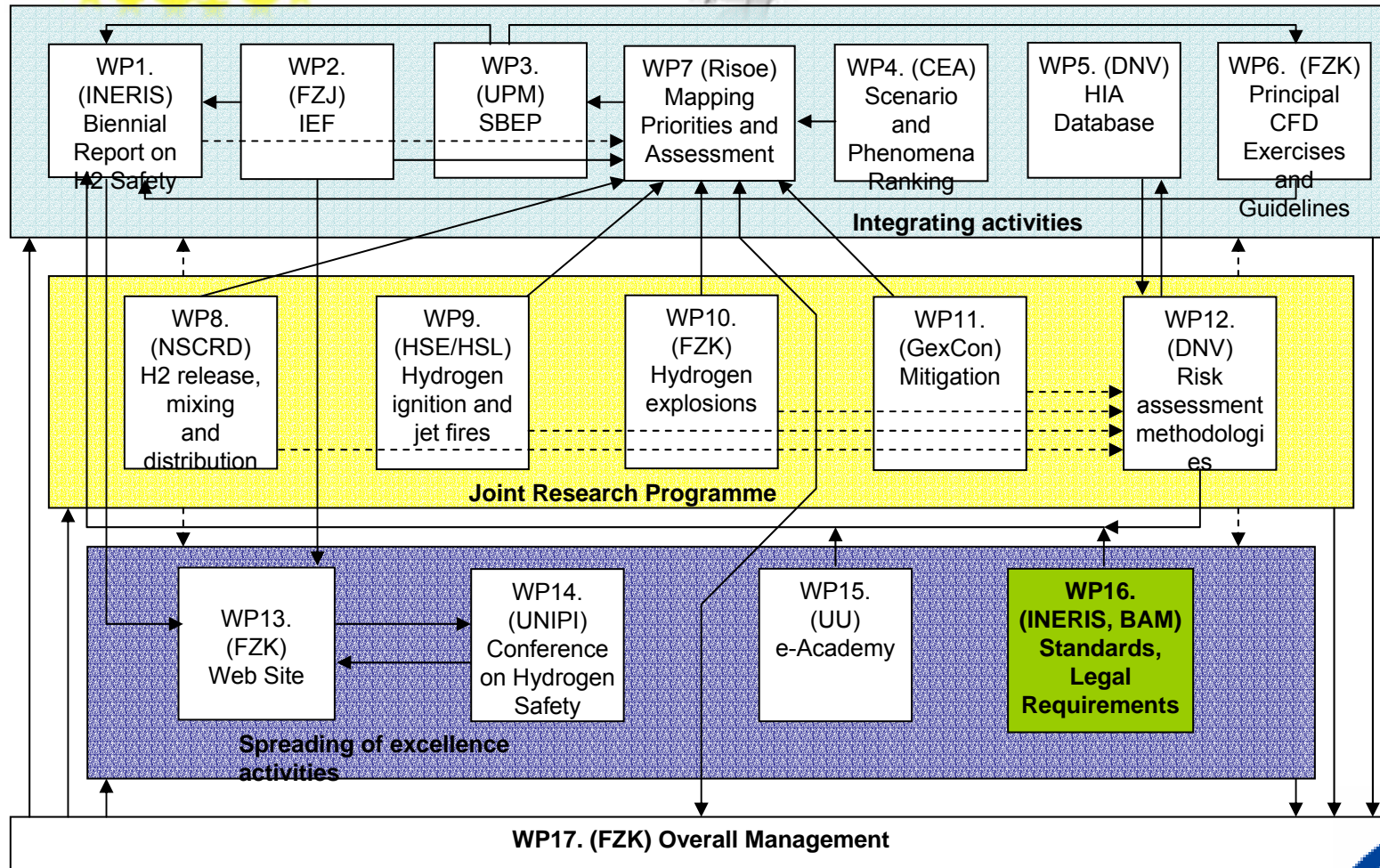
# Consortium



	Forschungszentrum Karlsruhe GmbH	DE
	L'Air Liquide	FR
	Federal Institute for Materials Research and Testing	DE
	BMW Forschung und Technik GmbH	DE
	Building Research Establishment Ltd	UK
	Commissariat à l'Énergie Atomique	FR
	Det Norske Veritas AS	NO
	Fraunhofer-Gesellschaft ICT	DE
	Forschungszentrum Juelich GmbH	DE
	GexCon AS	NO
	The United Kingdom's Health and Safety Laboratory	UK
	Foundation INASMET	ES
	Inst. Nat. de l'Environnement industriel et des RISques	FR
	Instituto Superior Technico	PT
	European Commission - JRC - Institute for Energy	NL
	National Center for Scientific Research Demokritos	EL
	Norsk Hydro ASA	NO
	Risø National Laboratory	DK
	TNO	NL
	University of Calgary	CA
	University of Pisa	IT
	Universidad Politécnica de Madrid	ES
	University of Ulster	UK
	VOLVO Technology Corporation	SE
	Warsaw University of Technology	PL



# Work Packages





WP16 shall provide, with the help of other WPs, the safety expertise required **to progress the development of appropriate standards, regulations & practical guidance** for the safe development and use of hydrogen technologies.



# Resources

## Efforts (month 1-18) :

- WP co-ordinators: INERIS and BAM : 2 person months
- Partners: 1 person month each on average

## Partnership

**co-ordination** : **INERIS** / France & **BAM** / Germany

**Air Liquide** / France

**BMW** / Germany

**BRE** / United Kingdom

**CEA** / France

**HSL** / United Kingdom

**JRC** / Netherlands

**Norsk-Hydro** / Norway

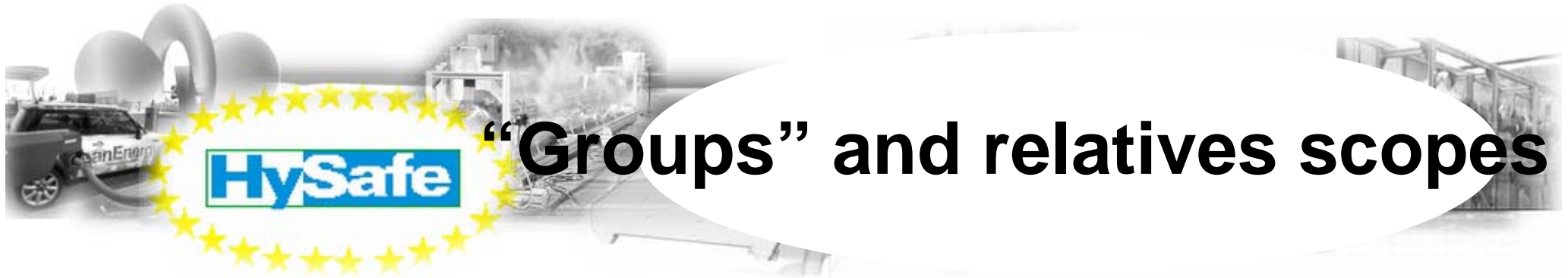
**Risoe** / Denmark

**Volvo** / Sweden



# Definitions

	Regulations	Codes	Standards
<b>Definition</b> (taken from HySociety D10, based on Webster's Encyclopedic Unabridged Dictionary...)	A rule or order prescribed by authority, as to regulate conduct (Synonymous: legislation, directives,...)	Any system or collection of (rules and) regulations	An object, considered by an authority or by general consent as a basis of comparison or anything as a rule or principle that is used as a basis of comparison
<b>Purpose</b>	to protect the public, workers, the environment, values ... from dangers		to support the free exchange of goods and services
<b>Legal power</b>	compelling		Not a requirement, but useful
<b>Drivers</b>	normally politically motivated		normally industry driven



- IPHE (International Partnership on Hydrogen Economy)
- IEA (International Energy Agency) / Task 19 on Hydrogen safety
- ISO / TC 197 on Hydrogen technologies
- IEC / TC 105
- UNECE GRPE WP29
- European (CEN, CENELEC) standard organizations,
- Japanese (JARI-JEVA) standard organizations,
- American (SAE, ICC) standard organizations,
- European Commission,
- European HFC Technology Platform (IGRC&S),
- HYSAFE NoE,
- HarmonHy,
- EIHP,
- Other European projects...



# RC&S activities and relatives scopes

	Mapping and gap analysis	Co-ordination of actions	Edition of « standards »	Contribution to standards	Production of knowledge	Range
IPHE						IPHE Members
IEA						IEA Members
ISO						World Wide
IEC						W W
UNECE GRPE WP29			International regulation			Depends on agreement
EC		Work program			Funded	Co-ordination with IPHE
CEN	Mandate group		No significant work going on			Europe
HFCTP	IGRCS					Europe
HYSAFE		NoE		Inputs or drafts possible	Could be dedicated to standards	Europe or W W through ISO, IPHE(?)...
HarmonHy						Europe
EIHP				Draft regulation	Focussed on "standard development"	W W
Other EC Projects				No obvious inputs	Focussed on product development and not standard	W W if participation to ISO,...
National standard organisations in Europe			??	Mirror Committees		National
Japanese Standard organisation + Government		Seem to be politically driven	Development of National standards	Draft proposal for international standards	Funded	National
American Standard organisation + Government		Seem to be politically driven	National standards	Draft proposal for international standards	Funded	National & W W



# State-of-the-Art Survey

V1  
Hydrogen  
release,  
Mixing and  
distribution

V2  
Thermal and  
pressure effects  
from H2 fires  
and H2-air  
explosions,  
missiles

V3  
development  
and validation  
of hydrogen  
mitigation  
techniques

V4  
Safety assessment,  
Risk analysis and  
comparative risk

V5  
Standardisation  
and legal  
requirements

Total

	V1	V2	V3	V4	V5	Total
<b>H1 Production</b>	6	6	2	13	4	25
<b>H2 Transport and distribution, refuelling stations</b>	9	12	5	20	9	55
<b>H3 Storing H2 (LH2, CGH2)</b>	4	6	2	16	7	35
<b>H4 Vehicles powered with H2</b>	4	6	0	16	10	36
<b>H5 Tunnels, parking garage</b>	1	4	2	3	5	15
<b>H6 Utilisation, portable and stationary H2 applications</b>	4	3	2	13	3	25
<b>H7 Nuclear applications</b>	6	5	9	9		29
<b>Total</b>	28	42	22	90	38	220



- “Phenomena Identification and Ranking Table” exercise is being conducted with the objective of identifying and prioritize R&D needs in the area of H2 safety
- PIRT exercise consists of two steps:
  - 1) identification and ranking of accidental events (***safety-oriented vote***), August – December 2004 results in Deliverable D12, summarized on next foil
  - 2) focus on the phenomena associated with the most important accidental events (***phenomena-oriented vote***) will be conducted January – May 2005.



# Safety Orientated Votes

insHYde Proposal (Ses.B)

HyTunnel Proposal (Ses.B)

Conclusions for H1 (PRODUCTION) votes:

Events associated with **small or large leaks of H2 from electrolysis systems into confined volumes** have been ranked as the most important safety issues.

Conclusions for H2 (TRANSPORT AND DISTRIBUTION) votes:

**Crash of GH2 and LH2 tankers in tunnels scored the highest** averages (resp. 2.96 and 3.0) of all events – over all applications, underlying the importance of addressing tunnel safety issues (this is done under H4 for commercial vehicles and passenger cars) especially with vehicles transporting large quantities of H2 such as tankers . More generally, high votes were awarded for accidental issues involving accidental discharges via ruptures of line or dispenser hose, or even tank rupture situations for **road tankers involved in traffic accidents**.

Issues related to pipeline transport generally scored less, expressing perhaps that this is an industrial practice with high safety records, or that these pipelines are situated in less populated areas than those through which H2 tankers would circulate. There is one exception, namely **instantaneous release of H2 from pipeline**, which score 2.19 in for GH2 pipelines (Group 2) and which had a bimodal distribution with an average of 2.0 for LH2 pipeline (Group B). These issues need to be investigated further.

Conclusions for H3 (LARGE SCALE STORAGE, REFUELLING STATIONS AND STATIONARY APPLICATIONS) votes:

Events concerning accidental releases (**small or large scale release rates**) from LH2 or GH2 **storage tanks** (through faulty or leaking connections, or, in the case of **refuelling stations**, at the level of the dispenser hose) **into confined or partially confined atmospheres** have received a high priority vote. The accidental release from an **APU inside a building** due to a leak or the opening of a safety valve, has also been considered a very important safety issue (confinement aspect). A number of safety issues specific to refuelling stations have either received a high priority or bimodal votes – (overfilling, car drives away, fire), so that these issues need to be looked at closely.

NATURALHY & HyApproval Coop.?





- The headlines  
**“Releases in (partially) confined areas”** and  
**“Mitigation measures (incl. sensors)”**  
have been derived
- Coherence with the IG-RCS preliminary gap analysis  
(Home production ~ small (electrolyser) releases in confined area, Tunnel delivery, Location & Set-Back ~ Zoning & Q-D, refuelling issues, Proximity to other fuels ~ ambient fires, Weight & Measures ~ *safety relevance?*)
- Input to the HFP SRA was submitted
- The following internal projects with direct impact on RC&S have been proposed...



# Project Proposal “HyGuide”

## Assessment of available Q-D requirements

- Appropriate for H2 (GH2, LH2)?
- How to be translated for different applications?
- Enabling critical applications  
by removing over-conservatism
- as a usual and useful tool part of most general  
Safety Assessments

(Request for funding in ENERGY-3 call)



# Proposal for “Best Practice Document”

- Guidance for all subsidized H2 handling EC projects
- Coherent and comparable safety approach
- Furthering exchange of experience feeding a common living database
- Obligatory safety audits (like for financials,...)
- INCREASED SAFETY
- Preparation of improved standard proposals



# Proposal for a CEN Standard

## „Performance Based Approach“

General Document on the

- SYSTEMATIC
- PERFORMANCE-BASED
- SCIENTIFICALLY GROUNDED

approach to assess hydrogen safety of various applications  
and assist in development of reliable hydrogen safety  
systems

(intrinsic, prevention, mitigation, etc.)

Not competing with e.g. the ISO TR 15916 (E), rather  
Similar to GOST 12.1.004-91 (Russian standard)



## Proposed WP work...

... with RC&S relevance:

### **„Hazard Zone Concept“**

Check whether existing standard may be directly applied to H2 applications

### **„ProbHy“**

Development of a probabilistic H2 ignition model eventually to be proposed as a standard



# Collaboration

- in the main standardisation bodies like ISO, IEC, CEN, CENELEC nearly all EU national bodies by personal (HySafe) representatives (“delegates”)
- IPHE via hosting the RC&S workshop at the **ICHS** and (depending on the NGB decision in 2 weeks) as a IPHE compliant project
- IEA same as for standards
- US, Canadian, Japanese collaboration via Network Advisory Council

ICHS, Pisa (I), September 8-10, 2005

**In Association with:**

**HySafe**  
The EU NoE  
"Safety of Hydrogen as an Energy Carrier"

**ARDENTHY**  
Development of Safe Utilizations and Infrastructure of Hydrogen, NEDO Project, JAPAN

**CUTE EU PROJECT**

**IPHE**  
International Partnership for the Hydrogen Economy

**NATURALHY EU PROJECT**

**STORHY EU PROJECT**

**ITALIAN NATIONAL FIRECORPS**

**With the Collaboration of:**

**INTERNATIONAL ASSOCIATION FOR HYDROGEN ENERGY**

invites you to the:

**ICHS**  
**International Conference on Hydrogen Safety**  
September 8-10, 2005  
Congress Palace  
Pisa, Italy

3<sup>rd</sup> Call for Papers



# Standardization worldwide

## ISO TC 197 « Hydrogen Technologies »

### Members

- 17 countries are P-members: Argentina, Australia, **Belgium**, Canada, Egypt, **France**, **Germany**, **Italy**, Japan, Republic of Korea, Libya, **The Netherlands**, **Norway**, Russia, **Sweden**, Switzerland, and USA.
- 12 countries are observers: Austria, China, Czech Republic, Hungary, India, Jamaica, Serbia and Montenegro, Spain, Thailand, Turkey, Ukraine, and United Kingdom.

### Work Status...



# Standardization worldwide

## IEC TC 105 « Fuel Cells »

### Members

- 15 countries are P-members: Australia, Canada, China, **Denmark**, **Finland**, **France**, **Germany**, **Italy**, Japan, Republic of Korea, **The Netherlands**, **Spain**, Switzerland, **United Kingdom**, and USA.
- 8 countries are observers: Austria, Belgium, Egypt, Norway, Poland, Portugal, Serbia and Montenegro, and Sweden.

### Work Status



- CEN mandate M349 « Feasibility study in the area of hydrogen and fuel cells »

### Existing CEN work

- CEN/CENELEC « Fuel cell gas heating appliances » - Draft in progress
- CEN TC19 « EWG on fuels for fuel cells » - on progress (transport application, tests, functional requirements,...)

### Why so few?

**Since we have an ISO, parallel actions committee making standards for hydrogen (TC 197), CEN does not have such a thing of CEN would do against the Vienna agreement... .**

### Why these ones ? Specific European need