Network of Excellence (NoE) HySafe
"Safety of Hydrogen as an Energy Carrier"

General Goal

Contributing to a **safe transition** to a **sustainable development** in Europe by facilitating the **safe introduction of hydrogen** technologies / applications

Objectives

- strengthen, **integrate** and focus fragmented **research** on hydrogen safety -> competitive scientific and industrial community
- Promoting **public awareness and trust** in hydrogen technologies
- development of an excellent safety culture

HySafe – Details

Consortium

- 24 partners from 12 European countries and one Canadian partner
- 12 public research organisations, 7 industrial partners, 5 universities

Time schedule

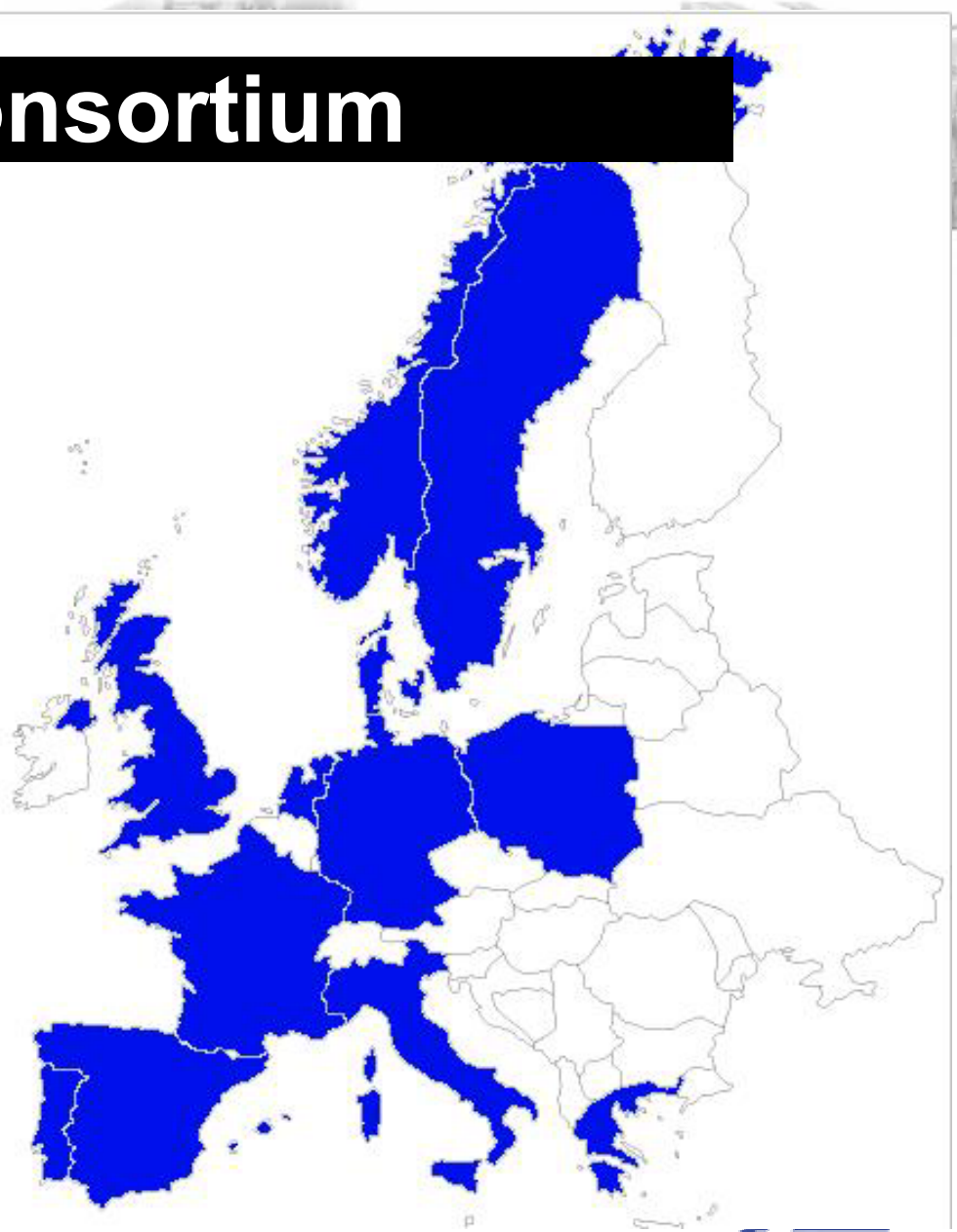
project start: 03/2004
duration: 5 years

Budget

Total 13 M€ with a EC grant of 7 M€

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'Energie 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



Experimental Facilities

Partners	Test facilities	Special features
BAM	Small and large-scale test facilities for material testing and gas explosion experiments	Large-scale explosion experiments at the outdoor test site
CEA	MISTRA facility (100 m³) for gas release and distribution experiments	Gas distribution and stratification tests, velocity measurements using LDV
FZJ	Small-scale test facilities for testing hydrogen mitigation devices	Detailed investigation of behaviour of hydrogen mitigation devices
FZK	Small-scale and large-scale facilities to study H2 explosion phenomena and H2 distribution	Robust confined volumes and wide range of scales (up to 100 m³). Possibility to study cases with slow flames, fast turbulent flames, DDT and detonations
Fh-ICT	Small and large-scale test facilities for H2 deflagration and detonation experiments	Test site for investigation of influence of components and surroundings under unconfined, semi-confined and confined conditions, high level measuring equipment
GexCon	Small and large-scale test facilities for explosion experiments	Broad spectrum of facilities, several facilities allowing video recording
HSE/ HSL	Small and large fire and explosion test facilities, facilities for assessing dispersion and mixing of both gaseous and two-phase flashing flows, facilities for ignition research, facilities for jet and pool fire testing, impact test facilities including air cannon and impact test track	Full scale ventilated tunnel/ enclosure facilities Testing of venting systems Testing of tank systems susceptibility to fire attack and impact Thermal imaging in short and long infrared windows Comprehensive optical based measurement system for velocity, temperature, species
INERIS	Facilities to study hydrogen combustion propagation in industrial pipes Facilities for studying unconfined jet release of hydrogen (free or impinged jet) Concentration field measurement and ignition study. Facilities for confined hydrogen explosion study and explosion venting (1 and above cubic meter spheres) Facilities for field measurement of slow release of hydrogen in confined spaces (garage), Facilities for pressurised tank and liquid tanks testing, tunnel	In house hydrogen sensors, High accuracy pressure sensors, High speed video, Ability to measure explosibility limits, combustion velocity, ignition temperature, minimum ignition energy,… Ability to compress hydrogen up to 700 bar, Ability to test mitigation / protection techniques (flame arrester, vents, suppressor, …)
JRC	Full-scale tank-testing facility, solid-state storage facility	Special facility for cycling testing, refuelling behaviour, testing of H2 storage systems for automotive applications
TNO	Small and large-scale test facilities for combustion and explosion experiments, IBBC Bunker for (semi)confined explosions, rigs for testing confined explosions, detonation tube facilities, explosion facility (e.g. for testing rocket engines)	Tunnel explosions in traffic tunnel environment, explosions in the open field
UNIPI	Large-scale VEC facility (30 m³) for confined vented explosion experiments	Top and front views made of strong glass for video recording the transient
WUT	Detonation tube facility for studies of gaseous detonations	Detailed investigation on detonation phenomena

Numerical Tools I

Partner	Code	CFD/integral/other	Applicability area
BRE	JASMINE, SOFIE, CFX	CFD	V2: combustion and heat transfer; V3: mitigation
CEA	CAST3M coupled to	integral/CFD	V1: distribution/mixing V2: combustion; V3: mitigation
	SIDONHY	Two-phase 1D	V1: release from high pressure tanks
DNV	FLACS, CFX	CFD	V1: ventilation, dispersion V2: explosion, pressure effects; V4: risk assessment
	Phast	Integral	V1: release/dispersion and V4: risk assessment
FZJ	CFX4	CFD	V1: atmospheric spreading of H2-air-steam clouds, distribution in complex geometries V2: combustion of flammable H2-air mixtures
	LauV	Integral	V1: LH2 pool spreading and vaporisation on different grounds
FZK	GASFLOW	CFD	V1: distribution/mixing V3: mitigation devices
	COM3D, FLAME3D, DET3D		V2: combustion at different regimes V3: combustion mitigation
GexCon	FLACS	CFD	V1: ventilation, dispersion V2: explosion, pressure effects from dispersion/premixed V3: mitigation strategies; V4
HSE/HSL	Star CD, CFX, SOFIE, AutoReagas	CFD CFD	V1: mixing and distribution V2: combustion, V3: mitigation and V4: risk assessment
	Scope, Fred	Integral	
INERIS	PHOENICS, ARIARISK	CFD	V1: release, mixing and distribution
JRC	REACFLOW	CFD	V2: pressure effects from H2 explosions Simulations within confined/semi-confined geometries

Numerical Tools II

Partner	Code	CFD/integral/other	Applicability area
NCSRD	ADREA-HF	CFD	V1: release, mixing and distribution V3: mitigation (venting, water spraying)
	GAJET	Integral	V1: discharge from CGH2 system
NH	FLACS Fluent, KAMELEON	CFD	V1: high pressure discharges, high speed jet impingement, in- and outdoor dispersion V2: combustion and explosions
	PHAST	Integral	
Risø	GReAT REDIPHEM	Integral	V1: outdoor buoyant plume dispersion, “instantaneous” concentrations V4: methodologies for RA
		Database structure for dispersion tests	
TNO	AutoReaGas	CFD	V1: dispersion; V2: explosion and pressure effects
UC		CFD (2D, 3D)	V2: combustion, detonation; V3: venting, pressure effects V4: simulation of accident scenarios
UPM	CFX4	CFD	V1: distribution, mixing, heat transfer; V2: combustion V3: mitigation (venting, recombiners) V4: methodologies for RA
	MELCOR	Integral	
UU	CINDY	Integral	V1: distribution/mixing: V2: accidental combustion; V3: mitigation (venting, water spraying) V4: risk assessment (modelling of consequences)
	FLUENT	CFD	
WUT	ZND	Detailed chemistry	V2: combustion
	DL	CFD (1D)	
	DETON	CFD (2D)	
	KIVA-3V	CFD (3D)	V1: release/distribution/mixing

Work Program Structure

Integration

- **experimental facilities and computational methods**
- **definition of standard benchmarks**
- **databases for incidents/accidents**

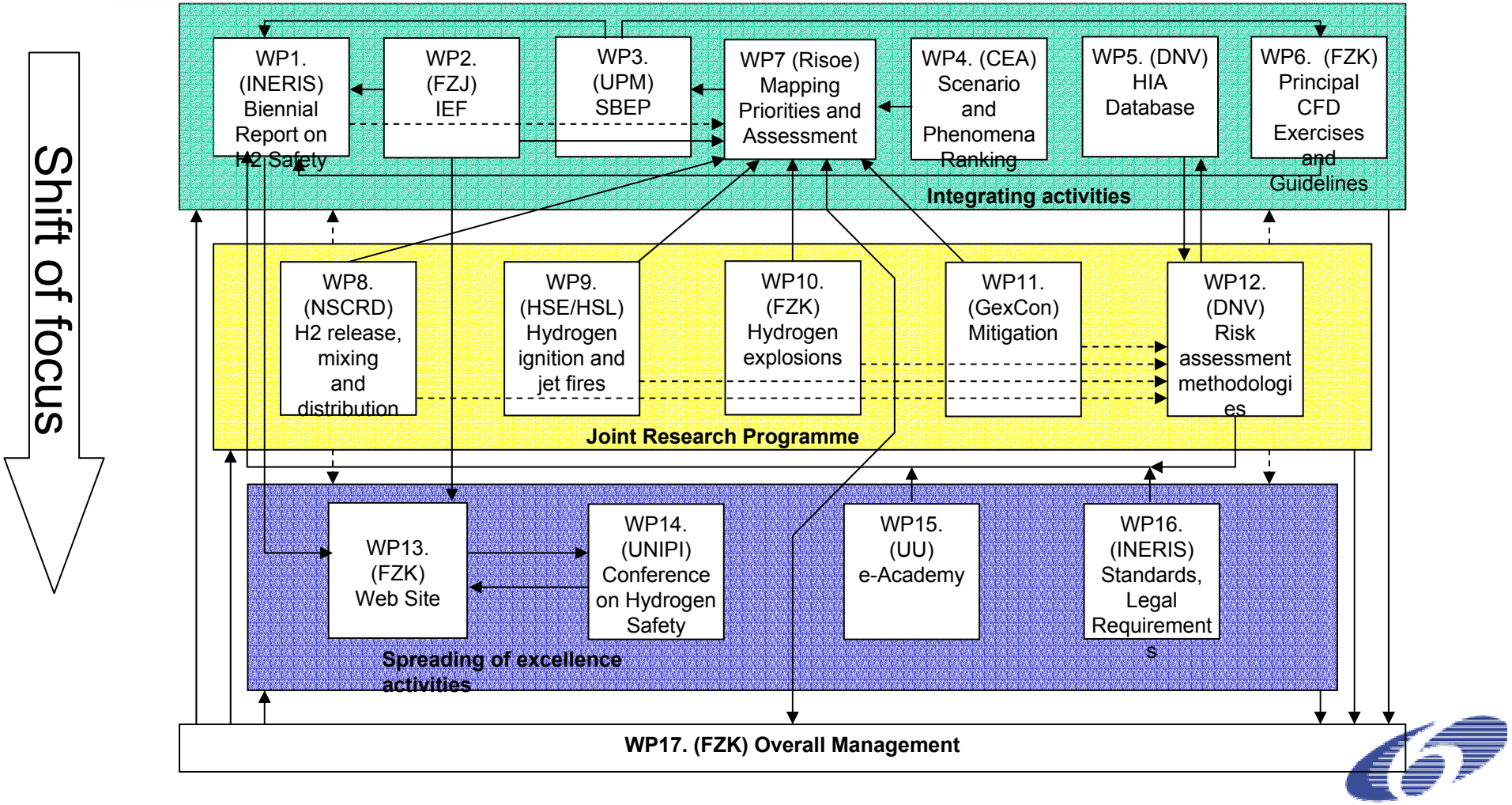
Joint Research

- methodologies for hydrogen release, mixing and distribution hazard evaluation associated with fires, explosions
- mitigation techniques

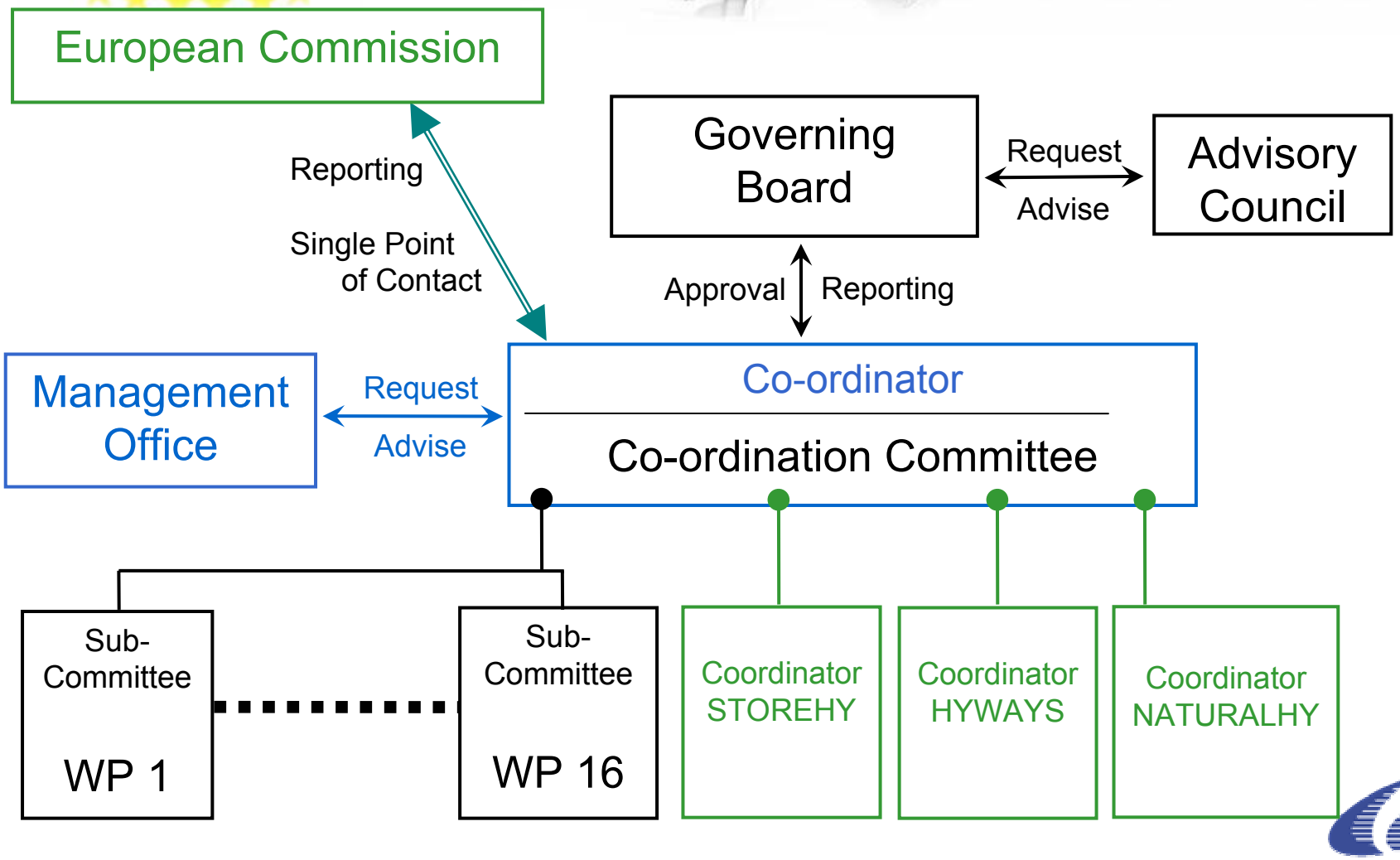
Spreading of Excellence

- Organisation of an Int. Conf. on Hydrogen Safety
- biennial report on hydrogen safety
- HySafe-website www.hysafe.org
- e-Academy

Internal Networking



Organisational Structure



Thematic Structure

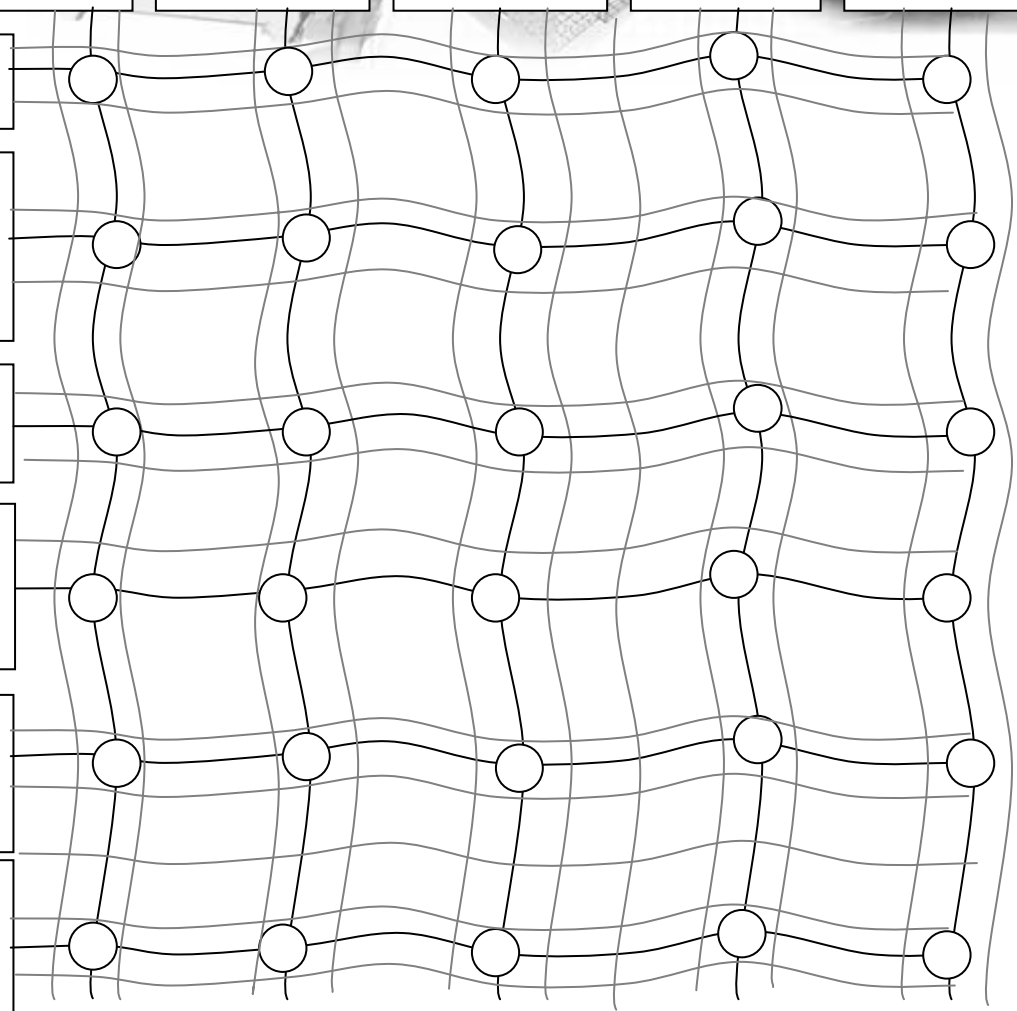
HySafe

Hazards and risk

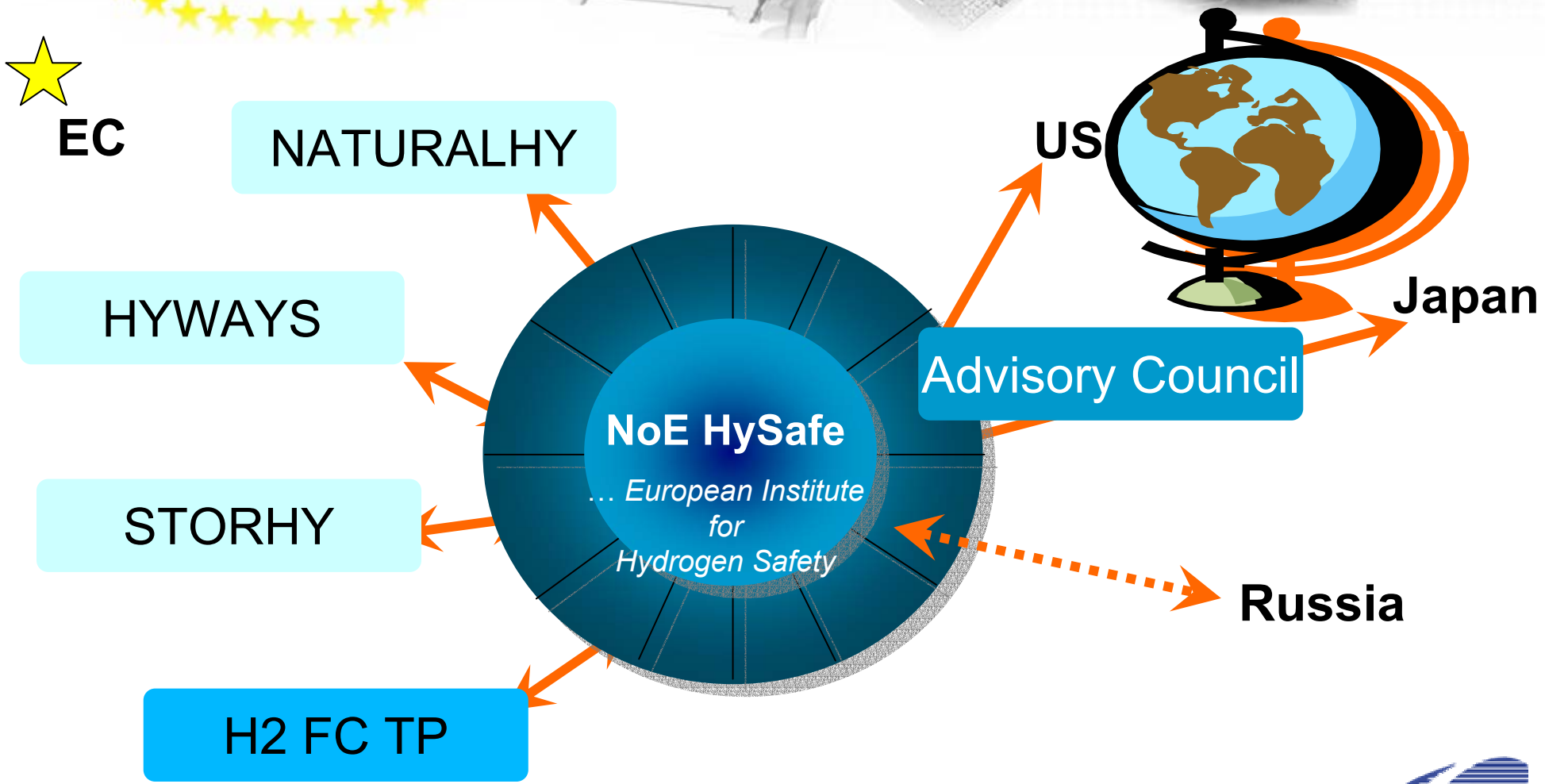
V1. Hydrogen release, mixing, and distribution	V2. Thermal and pressure effects from H_2 fires and H_2-air explosions, missiles	V3. Development and validation of hydrogen mitigation techniques	V4. Safety assessment, risk analysis, and comparative risk studies	V5. Standardisa-tion, and legal requirements

Applications and accident scenarios

- H1. Production
- H2. Transport and distribution, refueling stations
- H3. Storing H2 (LH2, CGH2)
- H4. Vehicles powered with H2
- H5. Tunnels, parking and garage
- H6. Utilisation, portable and stationary H_2 applications



External Networking



Current Activities

Integrating Activities

- Mapping and prioritisation of the future activities (PIRT action, survey,…)
- Solving the initial set of benchmarking exercise problems (SBEP) focused on hydrogen release, mixing and distribution and on fire and explosion phenomena
- Establishing the website www.hysafe.org as a communication platform
- Searching for a suitable large H2 project for the prototypical application of the networks safety assessments…

Project Proposals

- o Production - Safety Study for “LuxoTherm” Hydrogen Reactor
- o Storage - Concerted Safety Studies with StorHy
- o Distribution - HyApproval
- o Mobile Use - Improved Tunnel Safety for the Fuel of the Future
- o Rules - Development of Safety Guidelines for all H2 related, EC funded projects / project proposals
- o Education - Single partners application within the Marie Curie Program