Novel Education and Training Tools based on digital Applications related to Hydrogen and Fuel Cell Technology

Karlsruhe Institute of Technology

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Complementary to TeacHy

TeacHy
Teaching Fuel Cell and Hydrogen Science and Engineering Across Europe within Horizon 2020

- Development of Course Curricula
- Harmonisation of Course Curricula
- Development of Course Content
- Development of Course Materials
- Compilation to cc
- Complemental Le

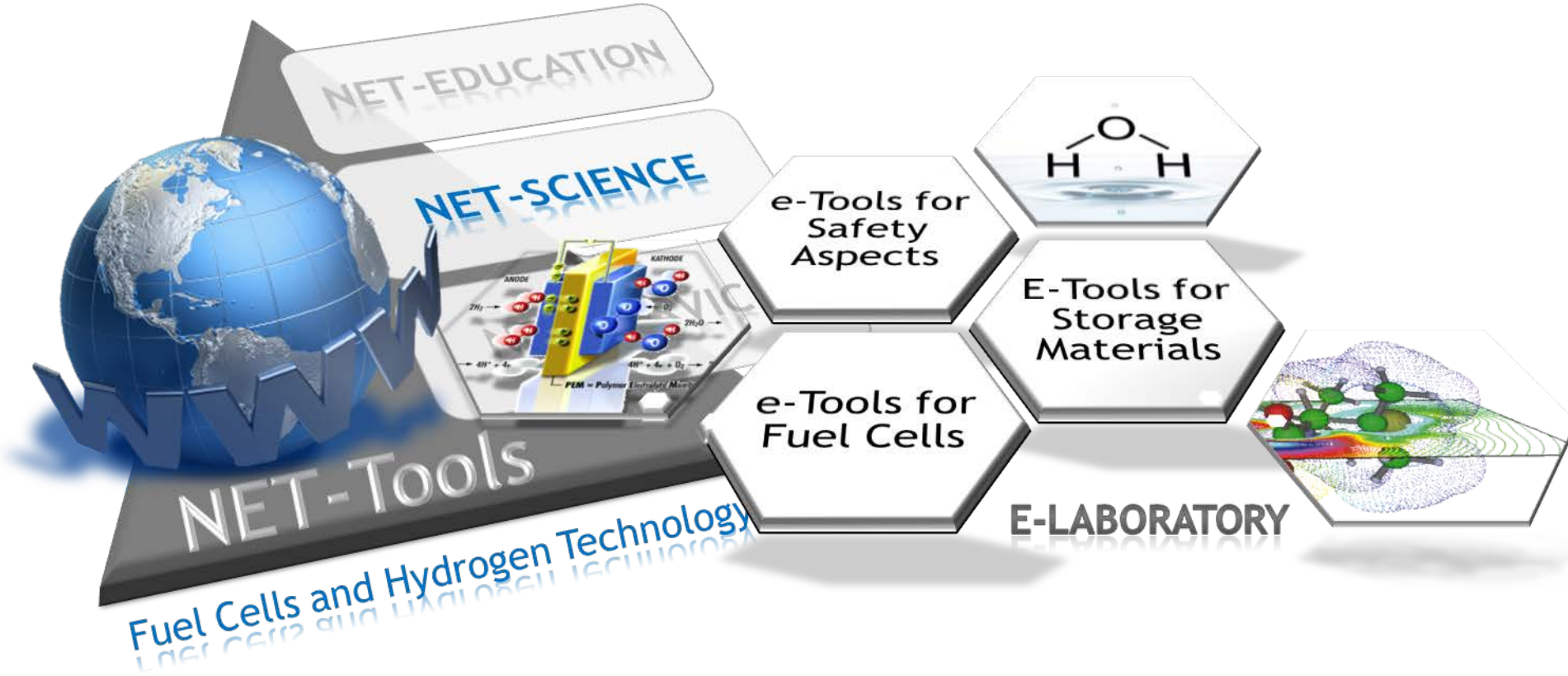
LMS

NET-TOOLS

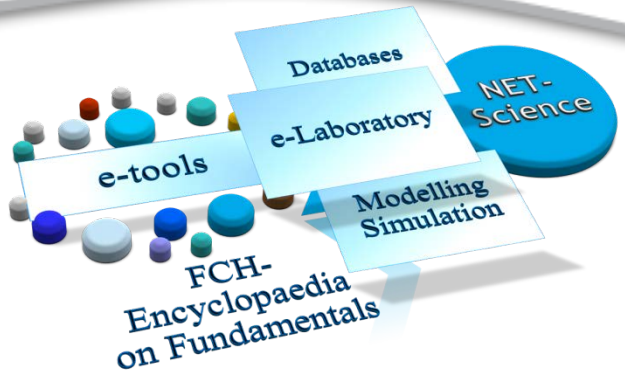
- Development of e-Platform
- Development of e-Tools
- e-Laboratory
- (engineering tools and scientific tools)
- e-Education
- e-model lectures
- Database
- Business concept

General Aim (graphical overview)

To develop, realize, promote and provide a common e-platform



General Objectives

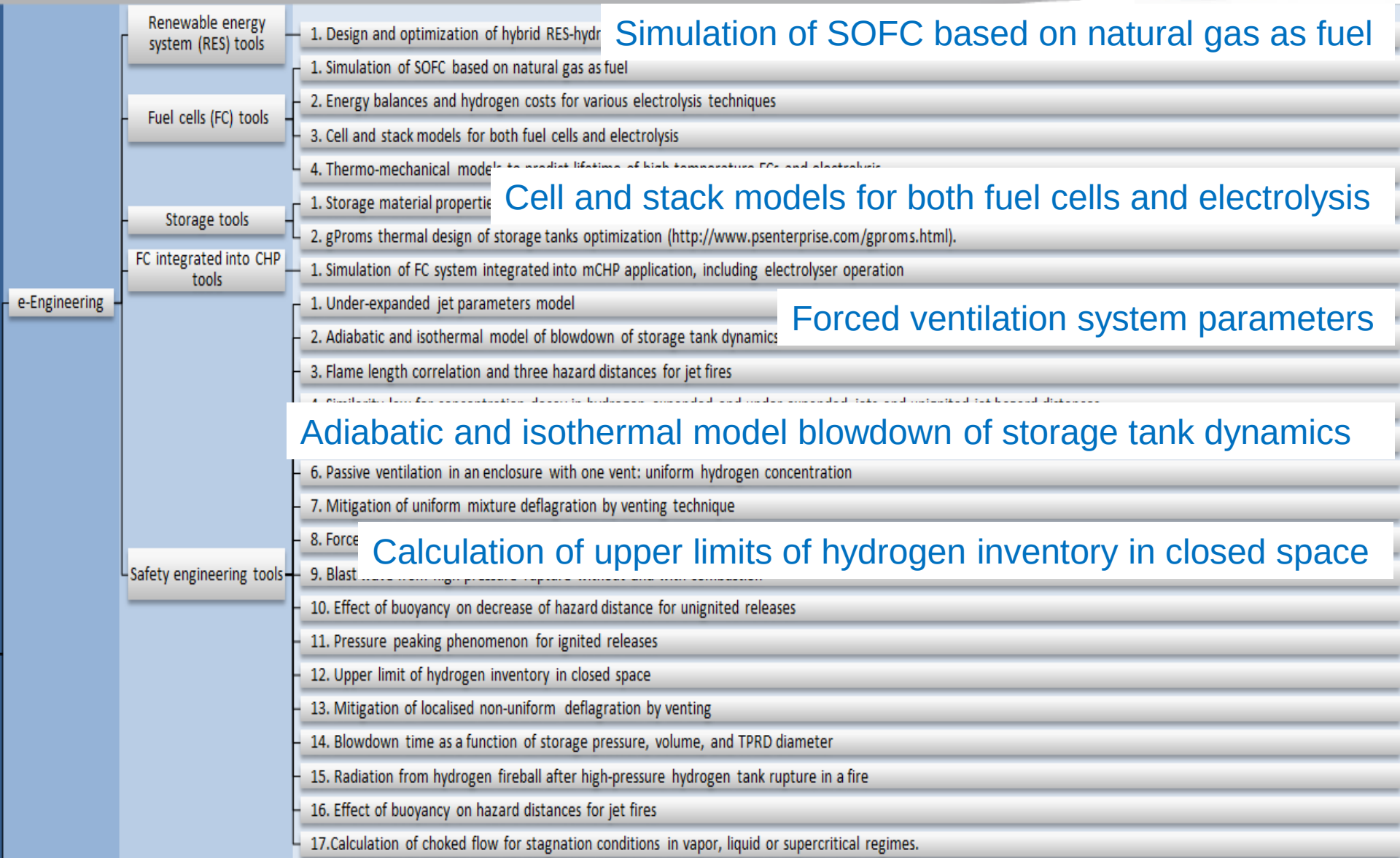


- Development of an e-Laboratory Platform

  subdivided into:

- e-Engineering Toolbox
  - Modelling and simulation of FCH related technical aspects
  - Guidelines and brief handbooks of e-tools
- e-Science Toolbox
  - Modelling and simulation of FCH relevant phenomena
  - Database of results received from done experiments
  - Database related CFD programming (validation and verification of codes)
  - Guidelines
- Database
  - Repository of done experiments and results
  - Guidelines and handbooks

e-Engineering (samples of tools)

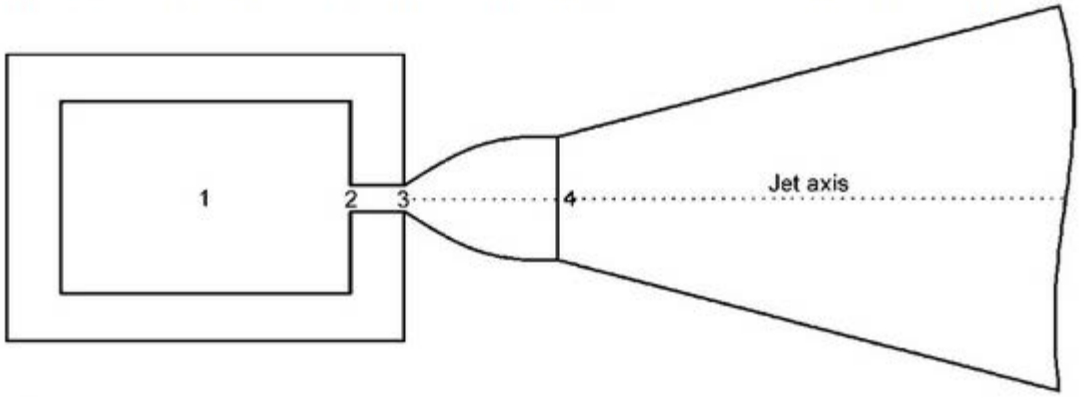


e-Engineering (explicit sample)

Cyber Laboratory

Underexpanded jet parameters

The model describes parameters in an underexpanded jet through characteristic stages of its development - in reservoir (1), orifice (3), and effective nozzle diameter (4). The model is based on Abel-Noble equation of state for hydrogen; conservation equations for mass and energy; assumption that at state (4) (so called "effective nozzle diameter") pressure is equal to the ambient one and velocity is equal to the local sound speed. The model does not account pressure losses in the nozzle (between states (2) and (3)).



Reference:

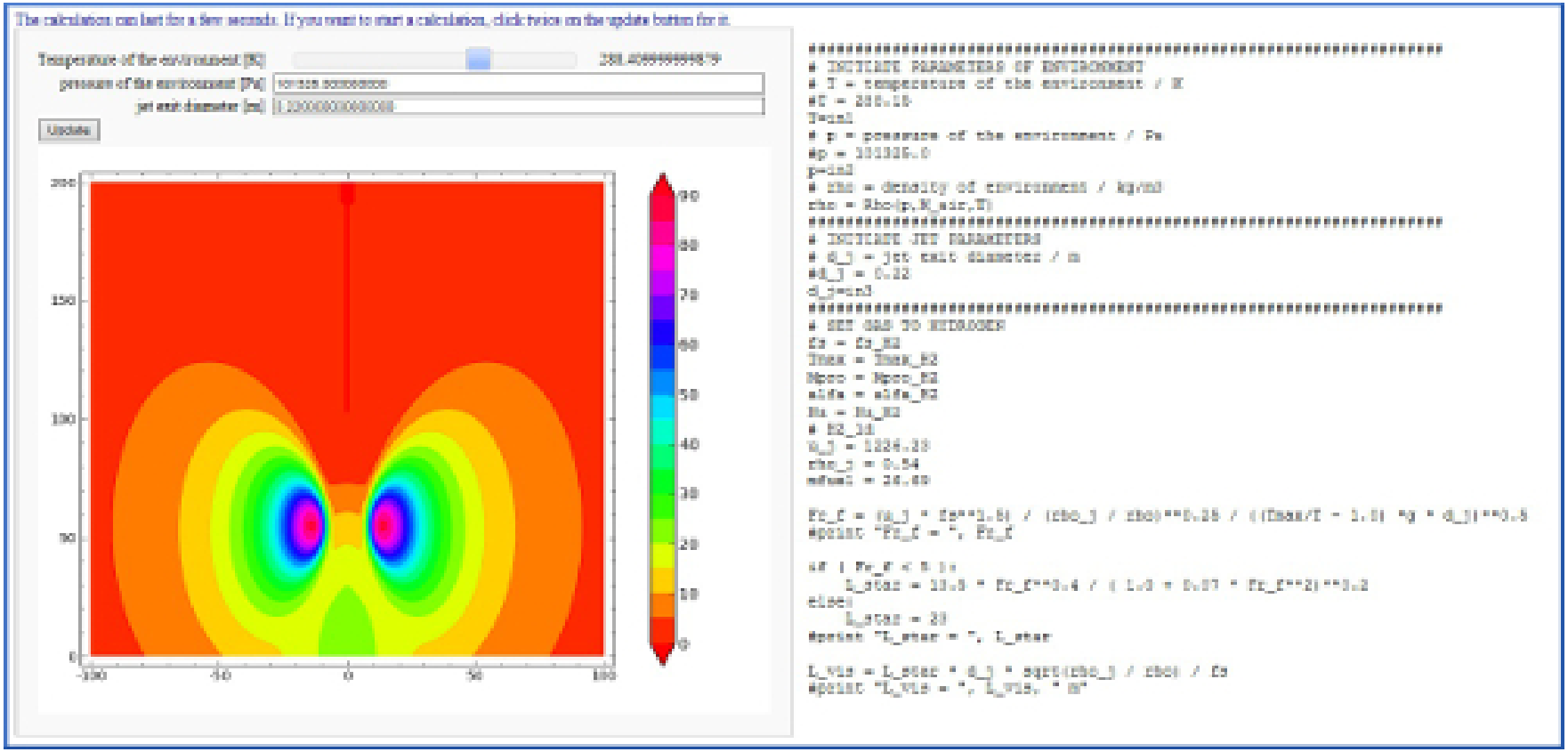
- Free eBook: V. Molkov Fundamentals of Hydrogen Safety Engineering", www.BookBoon.com, October, 2012

INPUT VALUES

Units for pressure input:	[bar]	
Pressure in tank:	700	[bar]
Temperature in tank:	240	[K]
Orifice diameter:	2	[m]
Ambient pressure:	650	[bar]

RUN

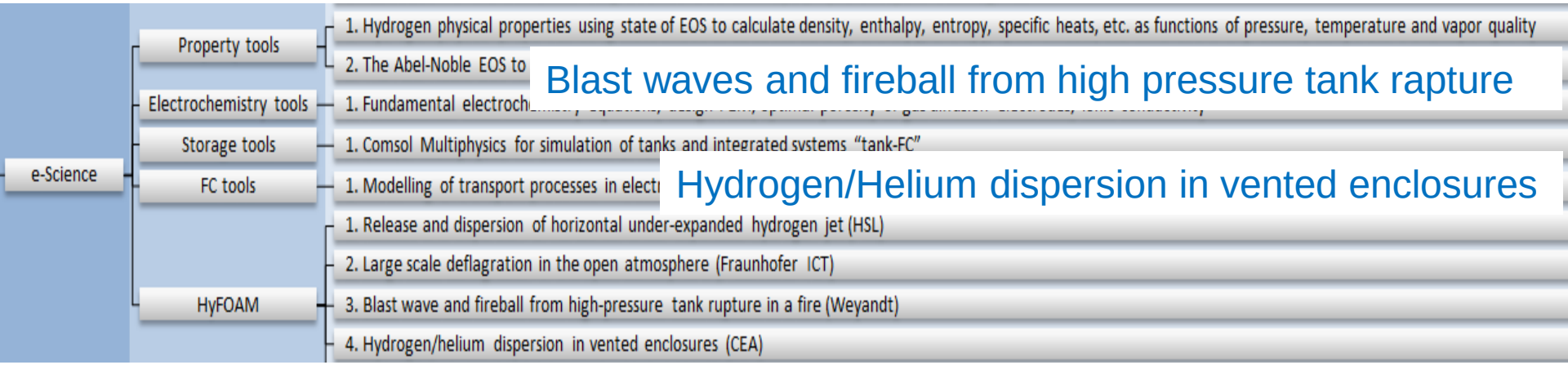
e-Engineering (flame radiation)



e-Science (samples of tools)

Thermo-physical properties of Hydrogen

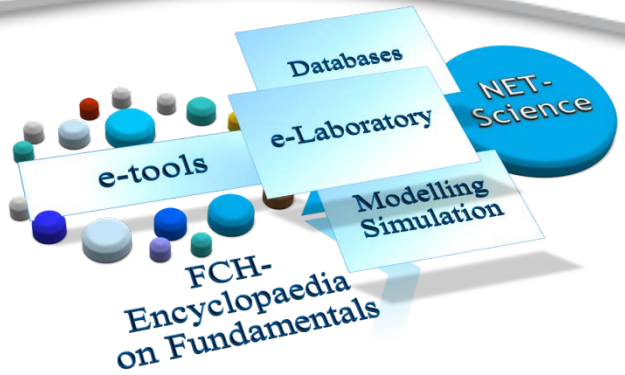
Release and dispersion phenomena



Blast waves and fireball from high pressure tank rapture

Hydrogen/Helium dispersion in vented enclosures

General Objectives



- Development of an e-Educational Platform

  subdivided into:

- e-Learning
  - Conventional Learning Management System (LMS)
  - Technical features to support users concerning communication, planning, exchange of documents, etc.
  - Quality assurance (probably review)
  - Guidelines
- e-Repository of FCH relevant information
  - Database
  - Documentations
  - e-books ?
  - Guidelines

E-Learning (explicit example)

- Educational materials
  - Course materials
  - Survey of existing course materials
- Specific Courses (Master Courses) in collaboration with **TeacHy**
  - Course Curricula (University level)
  - Content descriptions (based on modules)
  - Specific educational course materials
  - List of European Universities providing the master course (faculties, professors, lectures, etc.)
  - Access for students and teachers (lectures)
- e-Learning for Industrial Use
  - Typical industrial demands
  - Industrial level (technicians and engineers)
  - Facing industrial problems

Direct Collaboration and Inputs

- Expert Workshop (2018)
  - Stakeholders from Industry
  - Stakeholders from Academia
  - Advisory Board Members
  - Others
- Two Educational Schools (2018 and 2019)
  - To enrol and test NET-Tools e-platform on practical level (in operando)
  - Feedback for further improvement and development
- Flying Teachers
  - To enrol and test the acceptance of new teaching strategy in combination with NET-Tools
  - H2FC (Research Infrastructure Project)
- Newsletter

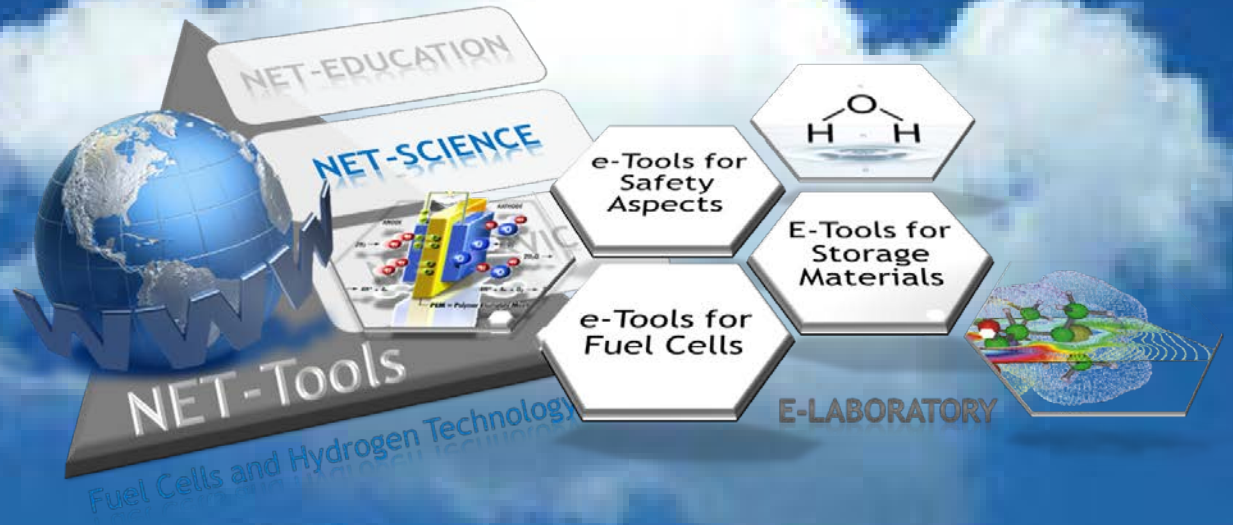
NET-Tools Conclusions

Development and compilation of specific e-tools

Development of e-Laboratory (scientific and engineering basis)

Development of e-Education (repository and LMS)

Development of e-Platform (cloud based) to provide e-Laboratory and e-Education under free access



TO PROVIDE an EUROPEAN DIGITAL PLATFORM to the FCH Community

NET-Tools Consortium

Acronym	KIT coordinator leader WP 1	Membership
KIT	Karlsruher Institute of Technology GERMANY (KIT) Research Organisation	ENERGHY
Acronym	**PersEE leader WP 2**	
PersEE	PersEE FRANCE Small and Medium Enterprise (SME)	Hydrogen Europe
Acronym	**NCSRD**	
ΔΗΜΟΚΡΙΤΟΣ	National Center For Scientific Research DEMOKRITOS GREECE University (Higher Education)	ENERGHY
Acronym	**UU leader WP 3**	
Ulster University	University of Ulster UNITED KINGDOM University (Higher Education)	ENERGHY
Acronym	**DTU leader WP 4**	
DTU	Danmarks Tekniske Univeritet DENMARK University (Higher Education)	ENERGHY
Acronym	**IEES leader WP 5**	
IEES	Bulgarian Academy of Science **BULGARIA** Institute of Electrochemistry and Energy Systems University (Higher Education)	ENERGHY
Acronym	**UNIPG**	
	Università Delgi Studi di Perugia ITALY University (Higher Education)	ENERGHY
Acronym	**EE leader industrial advisory board**	


NET-Tools
e-tools for
education in
modern
FCH-technology
Created by Olaf Jedicke