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

European Hydrogen Week
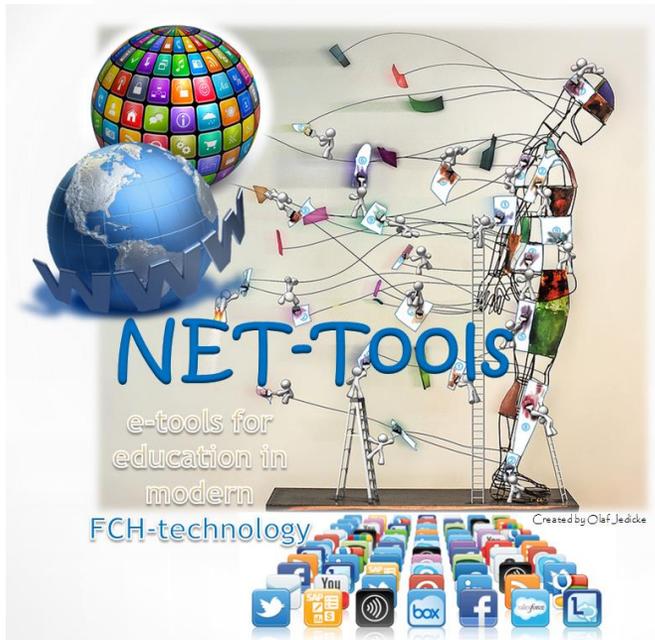
Olaf Jedicke

Karlsruher Institute of Technology

www.h2fc-net.eu

olaf.jedicke@kit.edu

#PRD2020
#CleanHydrogen

FCH

European Commission
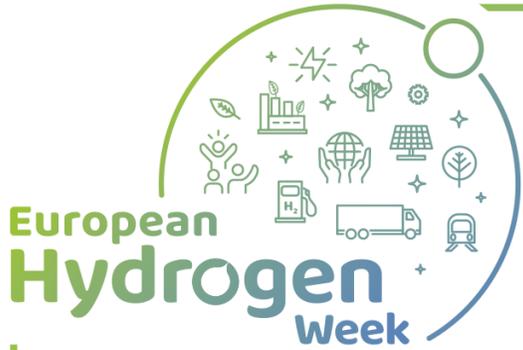
Project Overview

- Call year: [2016]

- Call topic: [H2020-JTI-FCH-2016-1; FCH-04-1-2016 Novel Education and Training Tools]

- Project dates: [01.03.2017 – (30.11.2020) by amendment]

- % stage of implementation 01/11/2019: [75 %]

- Total project budget: [1.596.007,50 €]

- FCH JU max. contribution: [1.596.007,50 €]

- Other financial contribution: [none €]

- Partners: [next slide]
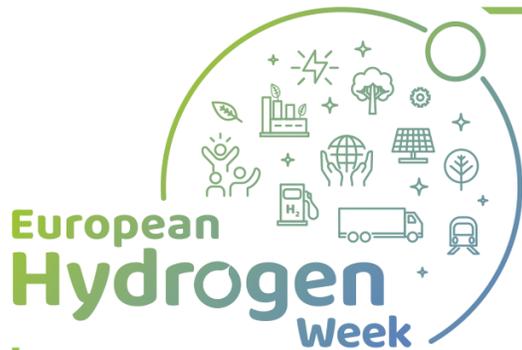
Partners

Ulster University

Karlsruher Institute of Technology **KIT**

Denmark Technical University **DTU**

Bulgarian Academy of Science (IEES)

PersEE
Persee

Element Energy
elementenergy

National Centre of Scientific Research

University Perugia
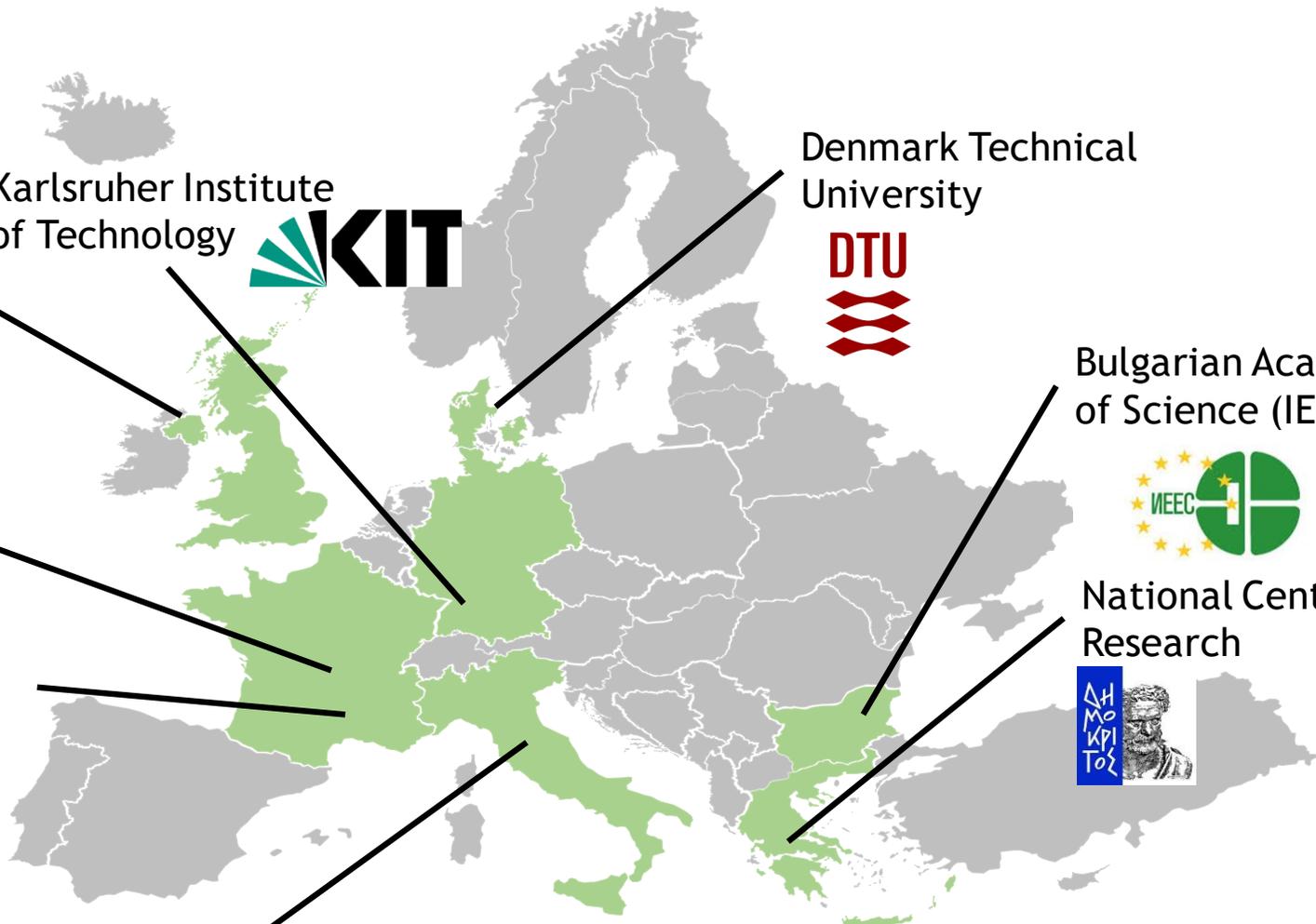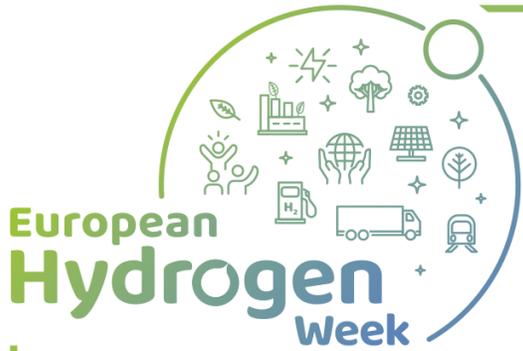
Project Summary

NET-Tools is developing an e-platform, containing an e-laboratory and e-learning part, interconnected by educational content, to support education and training in FCH-related topics. The project is aiming at both, broad university education and dedicated additional and continuing education within various industrial sectors.

NET-Tools guarantees different perspectives of the user (learner, teacher, developer, provider) with free access to the e-platform.
NET-Tools aims to insure the quality of provided e-learning materials and free access to the e-platform (by registration)
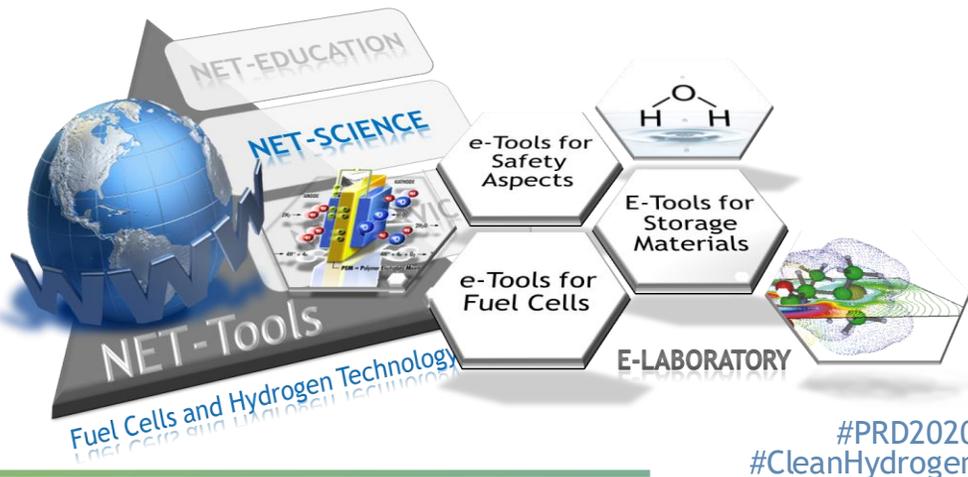
#PRD2020
#CleanHydrogen
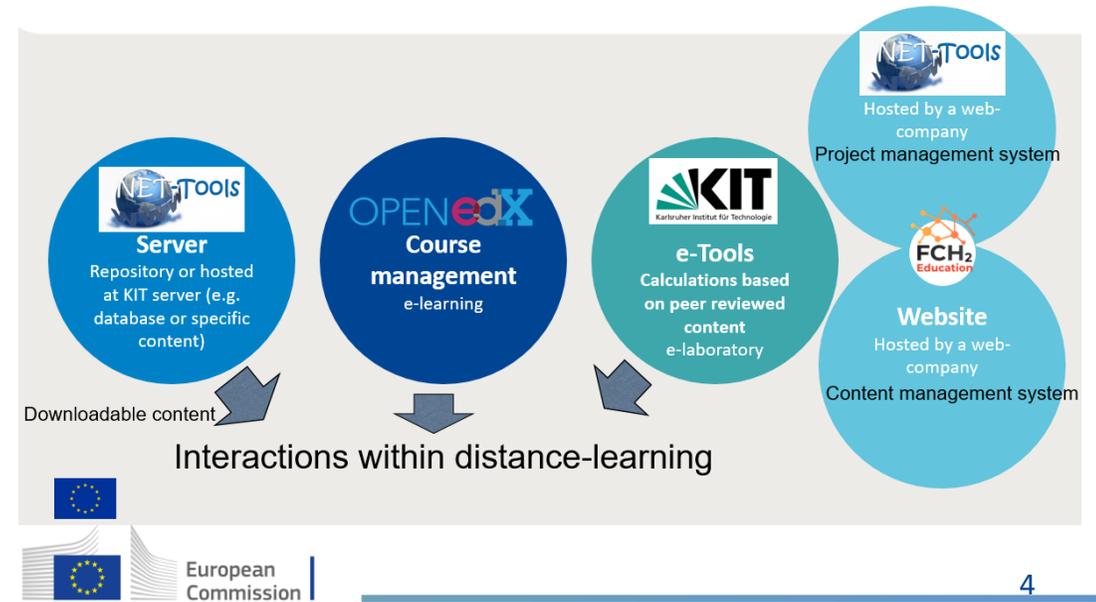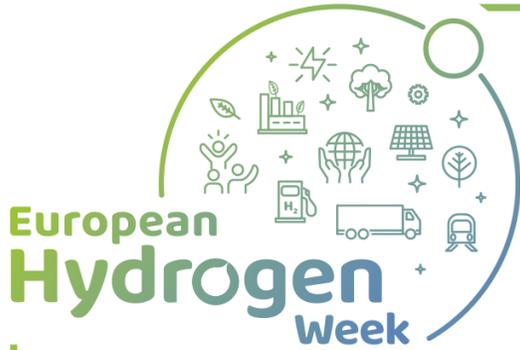
Project Summary

The technical implementation of e-laboratory and e-learning platform, the development and provision of useable educational content (MOOCs in different design) and e-tools within the e-laboratory and e-laboratory based on the <u>main objectives</u>:

- Technical implementation of the e-platform its handling, maintenance and features (MAWP, NIP)
- Separate implementation of e-laboratory and programing of useable e-tools for educational and engineering aspects (MAWP, NIP)
- Separate implementation of e-learning materials (MOOCs) compiled in short courses according FCH-relevant topics (MAWP addendum 2018)

The actual <u>international state-of the art</u> (only similar approach visible in US) NET-Tools could get into a lead position as e-platform for educational aspects within Europe. Main dependence is the willingness of cooperation and competing behavior of others.

<u>Application and market areas</u> are "education in general", means academic as well as industrial sectors to educate students, technicians, engineers but also providing overview knowledge to politicians, decision makers and administrative stuff

Project Progress/Actions – Aspects (1)

Achievement to-date   No KPI | Technical Implementation e-infrastructure | 100%

25%   50%   75%
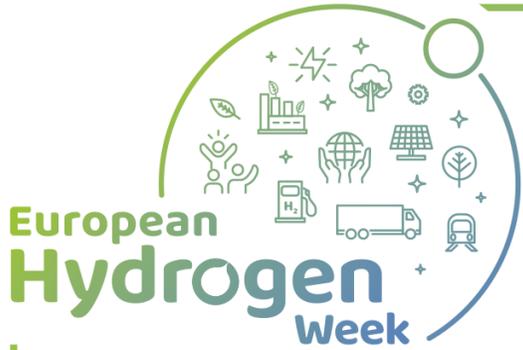
- **Technical Implementation of Open Source Based e-infrastructure**
  - Server based solution for the e-laboratory, practical maintenance and software updates
  - Implementation of e-learning via service provider open-EdX and MOOC Agency
  - Interconnection of both, e-laboratory and e-learning, through e-learning content (tasks and dedicated problems tailored to the application of the e-tools
- **NET-Tools website** runs as linchpin to connect to the e-learning platform and e-laboratory and to provide news, guidelines and instructions
- **Implementation of e-learning** platform (LMS) at open EdX
- **Implementation of platform** to develop and provide own e-learning content
- **Implementation of digital e-laboratory** workspace (distinguished between e-science and e-engineering)
- Reinstallation of **databases** at NET-Tools website, e.g. SUSANA database

Achievement to-date | 0 e-tools / 38 e-tools | **Development of e-tools to the e-laboratory** | 100%

25%   50%   75%
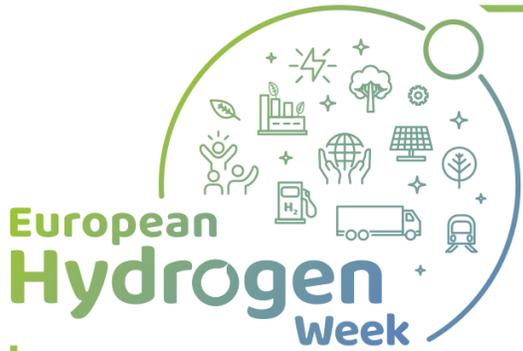
- **Development of e-tools to the e-laboratory**
- e-laboratory distinguished in:
  - e-engineering tools (for practical teaching and learning and technical pre-evaluation)
  - e-science tools (to support research e.g. modelling and simulation)
- Subdivision of e-tools based on relevant FCH themes e.g.
  - Tools concerning safety themes
  - Tools concerning electrochemical calculations
  - Tools concerning fuel cells (installation in simple private areas)
  - Tools concerning storage and thermodynamic behaviour of hydrogen
- Consolidation of existing e-tools and e-knowledge
- Quality assurance and IPR
- Engagement with and gaining traction from the wide FCH community

SORT BY CATEGORY
- ☑ Select All
- ☑ fc integrated into chp
- ☑ safety
- ☑ property
- ☑ electrochemistry
- ☑ modeling
- ☑ thermodynamics
- ☑ storage-separation
- ☑ renewable energy systems
- ☑ fuel cells
- ☑ production

#PRD2020
#CleanHydrogen

European Commission

Graphic material

x axis [J/kg/K]

y axis [K]
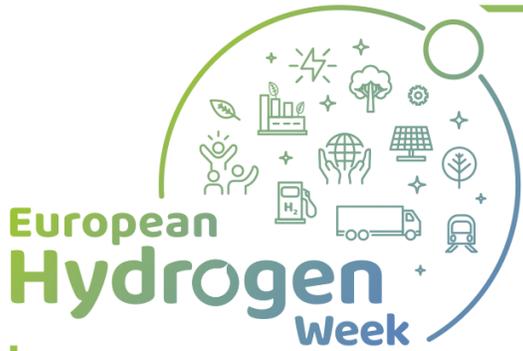
New calculation

Actions

Show description

Units

P_{tank} (Tank Pressure)	Pa
T_{tank} (Tank Temperature)	K
P_{amb} (Ambient Pressure)	Pa
T_{amb} (Ambient Temperature)	K
d_{noz} (Nozzle diameter)	m
ρ_{tank} (Tank density)	kg/m³
s_{tank} (Tank entropy)	J/kg/K
P_{noz} (Nozzle Pressure)	Pa
T_{noz} (Nozzle Temperature)	K
ρ_{noz} (Nozzle density)	kg/m³
s_{noz} (Nozzle entropy)	J/kg/K
W_{noz} (Nozzle velocity)	m/s
G_{noz} (Nozzle mass flux)	kg/m²/s
P_{fnoz} (Fict Nozzle Pressure)	Pa
T_{fnoz} (Fict Nozzle Temperature)	K
ρ_{fnoz} (Fict Nozzle density)	kg/m³
s_{fnoz} (Fict Nozzle entropy)	J/kg/K
W_{fnoz} (Fict Nozzle velocity)	m/s
G_{fnoz} (Fict Nozzle mass flux)	kg/m²/s
d_{fnoz} (Fict nozzle diameter)	m
$\dot{m}$ (Mass flow rate)	kg/s

Substance	ID_{subst}	1	
Tank Pressure	P_{tank}	2e+7	Pa
Tank Temperature	T_{tank}	298.15	K
Tank vapor quality	x_{tank}	1	
Ambient Pressure	P_{amb}	1.01325e+5	Pa
Ambient Temperature	T_{amb}	298.15	K
Nozzle diameter	d_{noz}	0.004	m
Fictitious nozzle model	$Model_{fnoz}$	1	
Tank density	ρ_{tank}	14.482	kg/m³
Tank entropy	s_{tank}	-21948.3	J/kg/K
Nozzle Pressure	P_{noz}	1.01155e+7	Pa
Nozzle Temperature	T_{noz}	244.429	K
Nozzle vapor quality	x_{noz}	1	
Nozzle density	ρ_{noz}	9.38705	kg/m³
Nozzle entropy	s_{noz}	-21948.3	J/kg/K
Nozzle velocity	W_{noz}	1290.38	m/s
Nozzle mass flux	G_{noz}	12112.9	kg/m²/s
Fict Nozzle Pressure	P_{fnoz}	1.01325e+5	Pa
Fict Nozzle Temperature	T_{fnoz}	298.15	K
Fict Nozzle vapor quality	x_{fnoz}	1	
Fict Nozzle density	ρ_{fnoz}	0.082353	kg/m³
Fict Nozzle entropy	s_{fnoz}	0	J/kg/K

Entropy $(J/kg/K)$

— Saturation
— ExpansionPath

Project Progress/Actions – Aspects (3)

Achievement to-date   0 courses   **Development of e-learning Materials**   85%
4 courses

25%   50%   75%
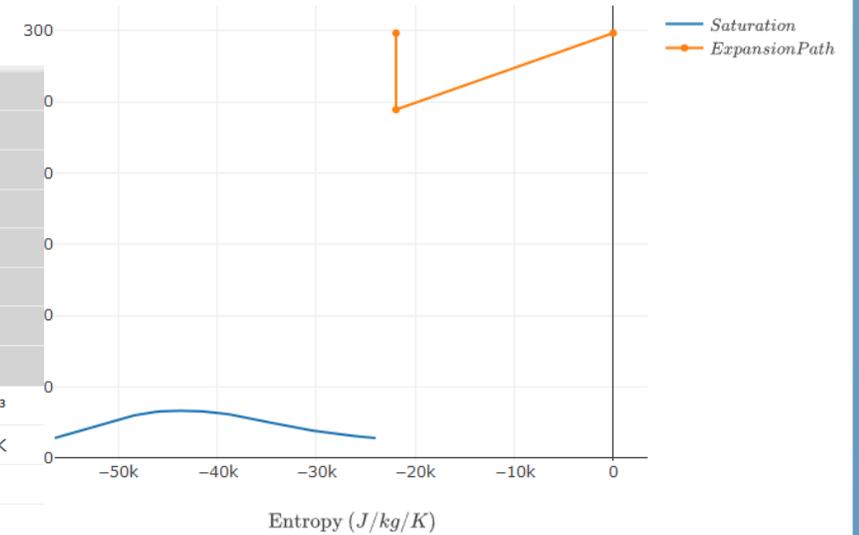
- **Development of e-learning Materials**
- e-learning materials compiled under different basic courses:
  - Use of Hydrogen (dedicated to Fuel Cells only)
  - Hydrogen Production (all methods including storage)
  - Hydrogen Handling (transportation etc.)
- Consolidation of existing e-education and e-knowledge
  - Demand on providing e-learning materials (MOOCs)
  - Quality assurance and IPR
  - Engagements of external participants and users

NET-Tools 2nd Educat.School
FCH H2 EDUCATION
fch2edu
2nd-Tech-School
MOOC - Example with exercises
Starts: Sep 29, 2020

Solid State Hydrogen Storage
FCH H2 EDUCATION
fch2edu
HHSD_01
Hydrogen handling, storage and distribution
Starts: May 20, 2020

Hydrogen Reuse
FCH H2 EDUCATION
fch2edu
HReuse02
Hydrogen Reuse
Starts: Aug 14, 2019

Graphic material
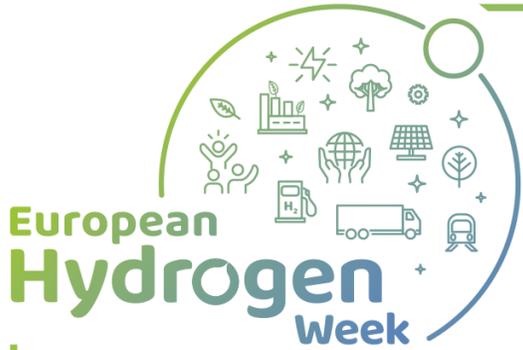
Risks, Challenges and Lessons Learned

Risks

- e-platform for educational aspects regarding FCH themes will get used less (both sides, learners and teachers)
- Promotion and support of e-platform will decrease beyond project life-time
- Financing of technical infrastructure regarding daily operation, volume of operation and its maintenance not guaranteed

Bottlenecks

- NET-Tools depend on the functionality of open-EdX and MOOC Agency
  - No direct interactions between e-laboratory and e-learning
- The engagement of external collaboration (users and developers)
  - To keep attractiveness new contents must get developed and provided
  - Development of e-tools not an easy task

FCH

European Commission
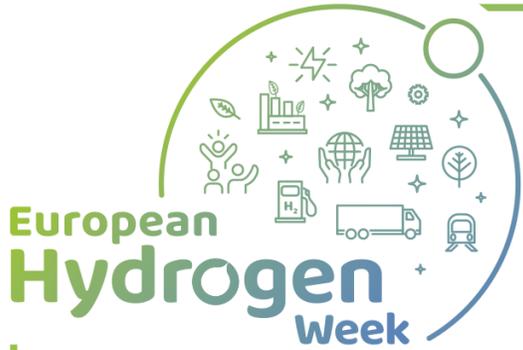
Risks, Challenges and Lessons Learned

Challenges (beyond the project life-time)
- To establish a financing background for continuous operation of e-platform
- To engage and motivate further users of e-platform (traffic by both sides)
- To keep attractiveness of e-platform by increasing and improving contents
- To ensure quality of provided e-learning and e-tools beyond project
- To support potential users and developers beyond project

Lessons Learned
- Nice to know about NET-Tools, but difficult to stay for collaboration
- Competition between single institutions (everybody like to have an own e-platform)
- Rejection by industry based on confidentiality of proprietary results

FCH

European Commission
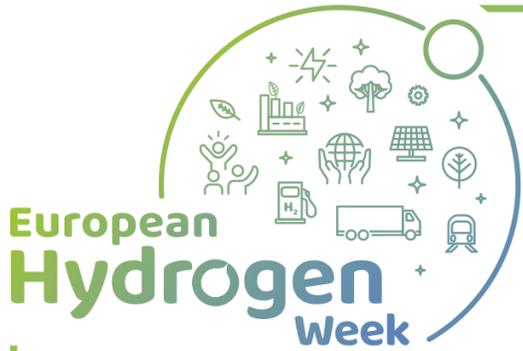
Exploitation Plan/Expected Impact

Exploitation

- Workshop to the development of technical architecture and contents of single sections
- 1st educational school
- 2nd educational school (webinar)
- 2 webinars to the usage of e-tools in safety concerns
- Test lessons at single Universities
- Presentations on different conferences and workshops (WHEC, EHEC, ECF, CzchHydDays, ICHS, etc.)
- Scientific Journals
- Own symposium at KIT
- Continued in 2021

Impact

- To foster the education of students and industrial stuff on FCH-relevant themes
- To offer an opportunity to each to educate or to get educated in FCH-relevant themes
- To hold available a technical base for operation in future, also for potential further FCH-projects
- To support industry and academia by providing usable e-tools for calculation

#PRD2020
#CleanHydrogen
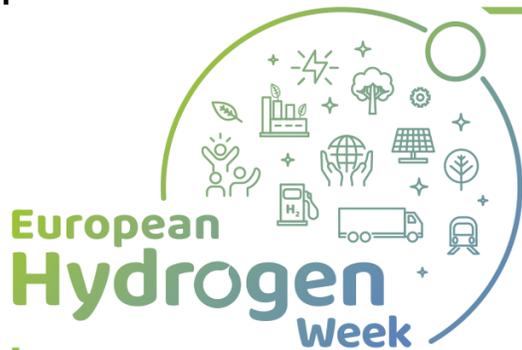
Synergies With Other Projects And Programmes

Interactions with international-level projects and initiatives

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

- Providing NET-Tools as e-platform to share e-learning contents
- Developing of e-learning content related to FCH-themes

FCHgo!

- Data Base for CFD modelling Hydrogen safety

SUPPORT SUSANA

Public Documents

The State-of-the-Art in Physical and Mathematical Modelling of Safety Phenomena Relevant to Fuel Cells and Hydrogen Technologies

Respect Copyright
This Document has been created within the FP7 project SUSANA. The utilization and release of this document is subject to the conditions of the contract within the 7th EU Framework Program. Project reference is Grant agreement no.: FCH-JU-325386
SUSANA Final Report D2.1 December 2016.p
Adobe Acrobat Dokument [11.3 MB]

DOWNLOAD

Critical Analysis and Requirements to Physical and Mathematical Models

Respect Copyright
Project reference is Grant agreement no.: FCH-JU-325386
SUSANA Final Report D2.2 December 2016.p
Adobe Acrobat Dokument [2.5 MB]

DOWNLOAD

Guide to Best Practice in Numerical Simulations

Respect Copyright
Project reference is Grant agreement no.: FCH-JU-325386
SUSANA Final Report D3.2 December 2016.p
Adobe Acrobat Dokument [15.5 MB]

DOWNLOAD
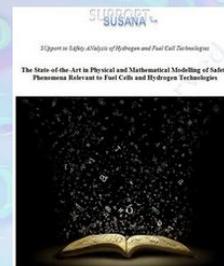
Communications and Dissemination Activities

- Workshop to the development of technical architecture and contents of single sections
- 1st educational school
- 2nd educational school (webinar)
- 2 webinars to the usage of e-tools in safety concerns
- Test lessons at single Universities
- Presentations on different conferences and workshops (WHEC, EHEC, ECF, CzchHydDays, ICHS, etc. up to 15)
- Scientific Journals (up to 15)
- KIT energy symposium hydrogen
- LinkedIn Account (frequently)
- Newsletters (up to 6)
- Twitter (frequently)
- Communication continued in 2021

Elitsa Petkucheva • 1st
Chief Assistent R&D at IEES-BAS
1yr

E-Learning is 🔵 line

You can already find Net-Tools developed course on

Fuel cells and hydrogen technologies

NET-Tools 2nd Educational School

Funded by European Commission
Contract No. 736648

Webinar on educational material
on hydrogen technologies
30th September – 1st October 2020

The NET-Tools consortium would like to invite you to the forthcoming webinar from the European initiative for educational material on hydrogen technologies which will be held on 30th September and 1st October 2020.

European Commission

Many thanks for the Attention

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

European Hydrogen Week

#PRD2020
#CleanHydrogen

FCH

European Commission