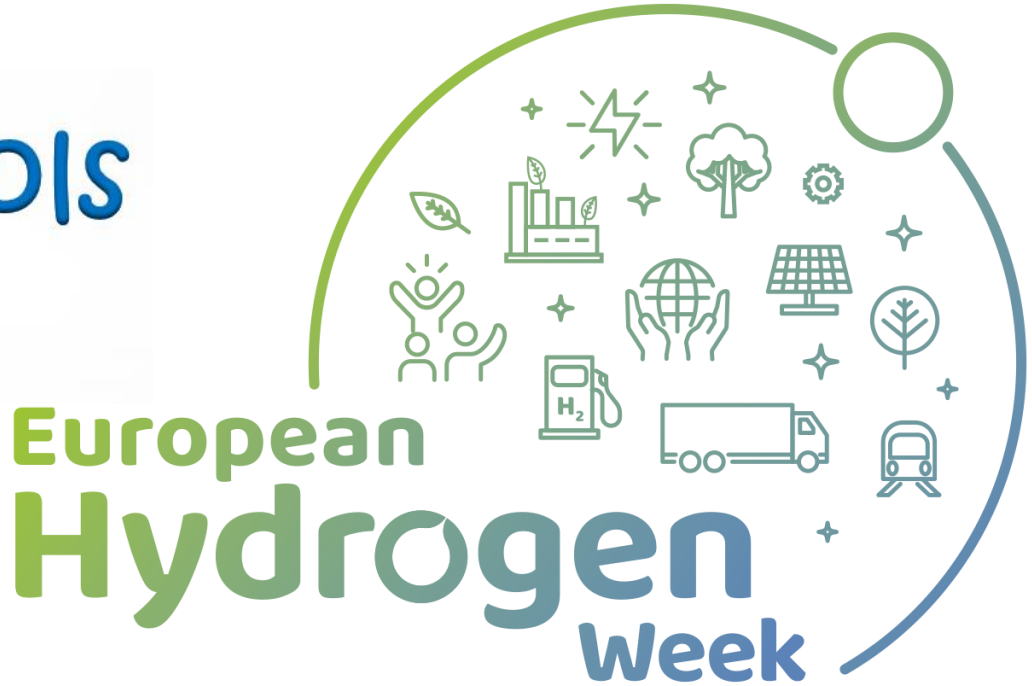
NET-Tools

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



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FCH

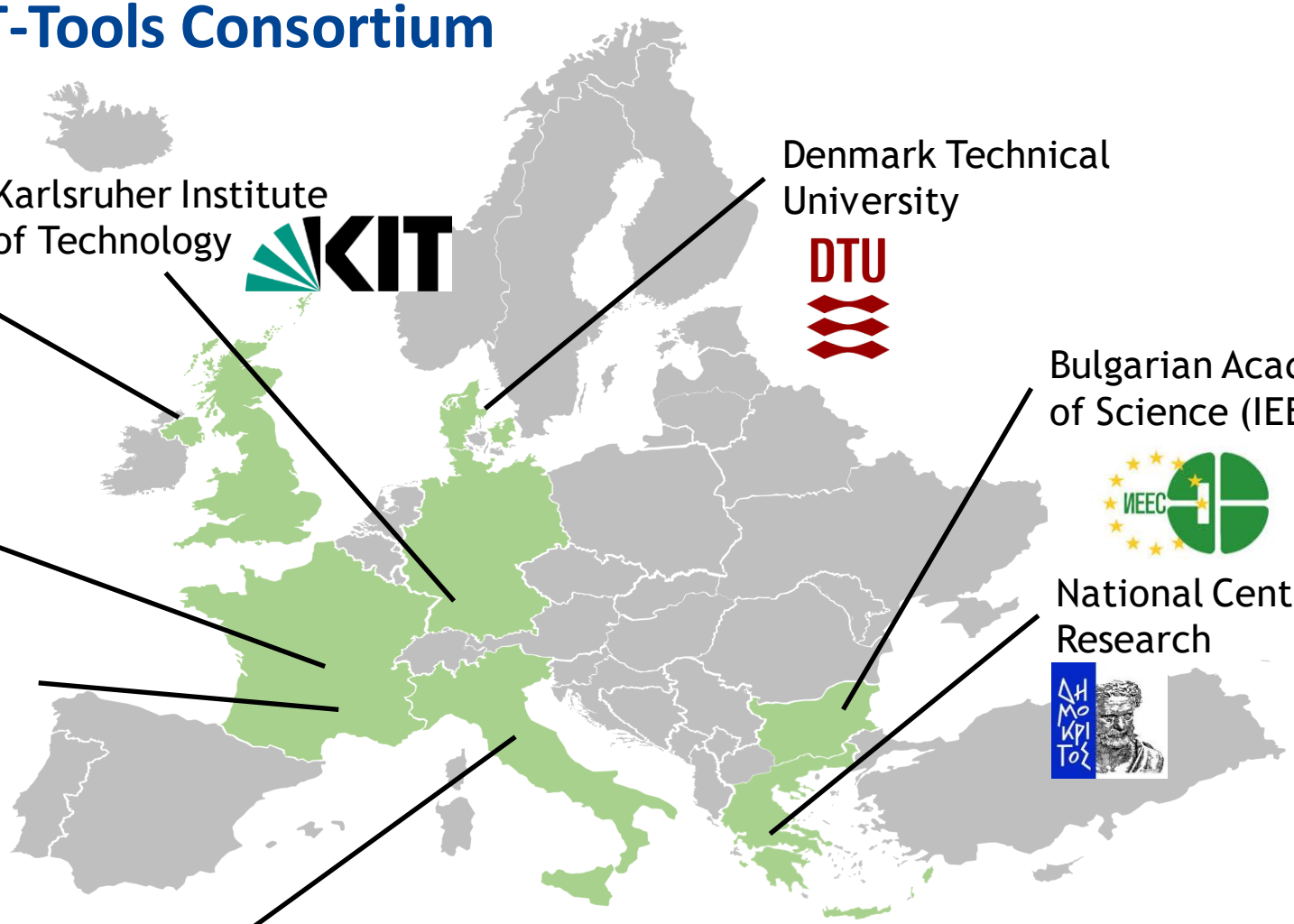
European Commission

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) 6 months extension by amendment]
- % stage of implementation 01/11/2019: [95 %]
- Total project budget: [1.596.007,50 €]
- FCH JU max. contribution: [1.596.007,50 €]
- Other financial contribution: [none €]
- Partners: [KIT, DTU, EE, UNIPG, UU, IEES, NCSRD, PersEE]

European Hydrogen Week

NET-Tools Consortium



Ulster University

Karlsruher Institute of Technology

Denmark Technical University

PersEE

Bulgarian Academy of Science (IEES)

Element Energy

National Centre of Scientific Research

University Perugia

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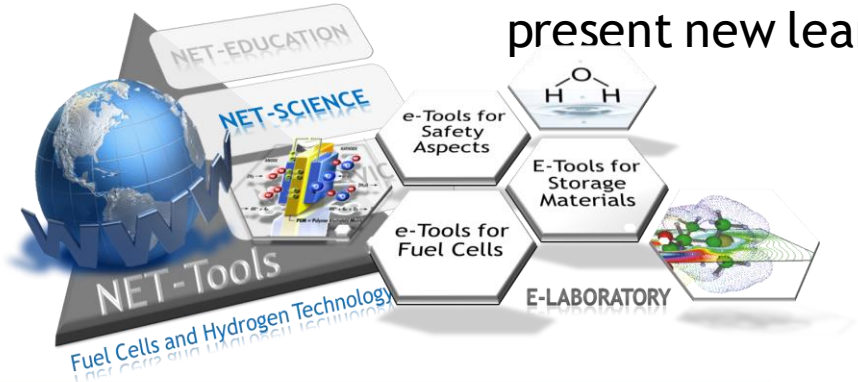
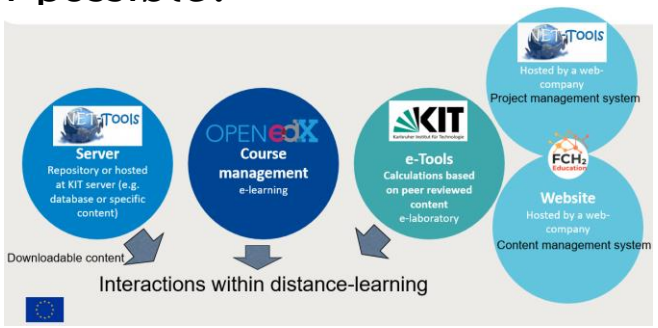
Project Summary

NET-Tools developed an e-platform, consisting of an e-laboratory and e-learning part, to interconnect educational content with practical exercises in case of education and training in FCH-related topics. Target groups for education and training are to be found on the side of university education (from initial studies to doctoral studies and beyond) and further on in the segment of targeted further education and training in industrial sectors dedicated to the topic or direct application of hydrogen technology and fuel cells.

NET-Tools guarantees perspectives and added value in benefits for different users (learners, teachers, developers, providers). Free access to the e-platform guaranteed to all users and interested parties (registration is however required).
NET-Tools strives to maintain the quality of the training content provided and also to present new learning content in the future, when ever possible.





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Project Summary

Main objectives of NET-Tools:

- Technical implementation and realisation of a digital service-platform for the development and processing of digital teaching content of all kinds (MAWP, NIP)
- Development and implementation of a specific e-laboratory for the development and use of e-tools concerning training, education and information purposes (MAWP)
- Development of a specified e-learning platform to provide educational content including exercises and additional materials (MAWP supplement 2018)
- Development and provision of free-to-use educational content (MOOCs in various forms) for demonstration (MAWP supplement 2018)

Current state of the art is reflected mainly by H2Tools platform (US). NET-Tools aims to adopt this model in the European context. The success is directly related to the willingness of others to cooperate but also further finding.

Market areas "educational service", i.e. academic and industrial areas for training students, technicians, engineers, but also the provision of knowledge and information for e.g. politicians, decision-makers.

Project Progress/Actions – Aspects (1)

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

25% 50% 75%

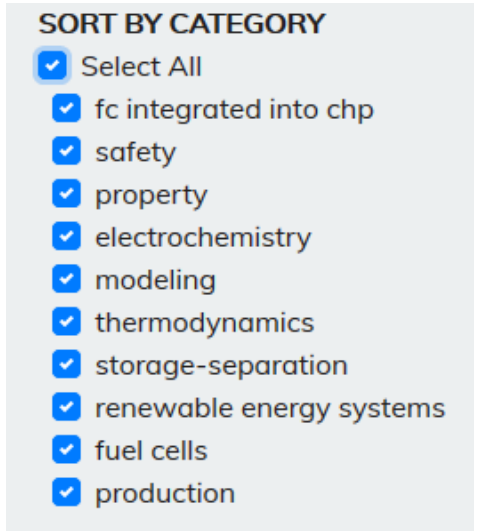
- **Technical Implementation of Open Source Based e-infrastructure**
  - Server based solution for the e-laboratory, practical maintenance and software updates
  - Implementation of e-learning via service provider open-EdX and MOOC Agency
  - Interconnection of both, e-laboratory and e-learning, through 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 also beyond project
- **Implementation of e-learning** platform (LMS) at open EdX
- **Implementation of platform** to develop and provide 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

Project Progress/Actions – Aspects (2)

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



Project Progress/Images - Aspects (2)

New calculation

Actions

Show description

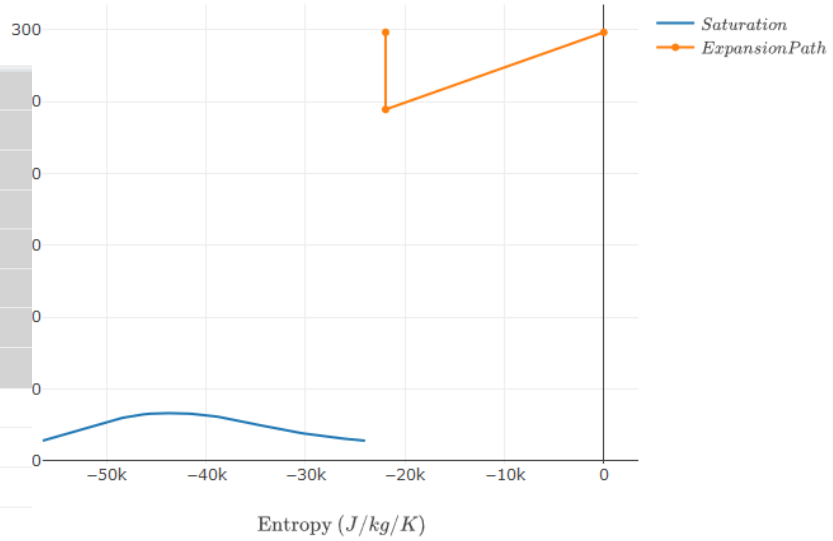
Units

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

x axis J/kg/K

y axis K



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Project Progress/Actions – Aspects (3)

Achievement to-date 0 courses / 4 courses → **Development of e-learning Materials** → 100%

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

Project Progress/Images - Aspects (3)

COURSE STAFF

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DTU-Energy Denmark

FCH2 EDUCATION

fch2edu

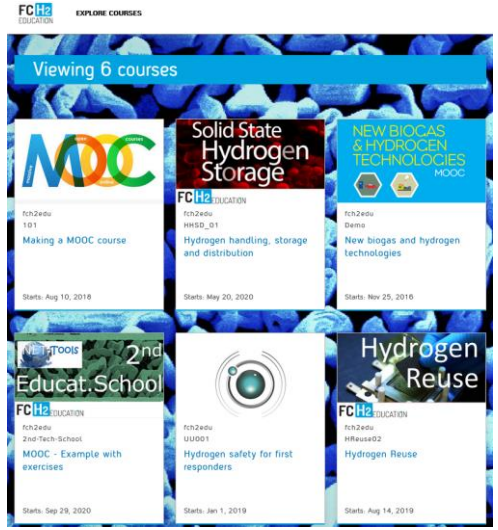
HReuse02

Hydrogen Reuse

Introduction on Hydrogen Reuse

Handouts

Download Handout



3.2.1 Principle of operation

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Risks, Challenges and Lessons Learned

Risks

- Project ended already

Bottlenecks beyond the project

- NET-Tools e-platform depend on the functionality of open-EdX and MOOC Agency and its technical interrelation
  - No direct interactions possible between e-laboratory and e-learning (two separate systems)
- The engagement and motivation of external collaboration (users and developers)
  - To keep attractiveness new contents must get developed and provided further on
  - The development and programming of e-tools is not an easy to perform
  - The financing of external costs to run e-platform

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
- To support potential users and developers

Lessons Learned

- Nice to have, 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

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 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 of technical problems and pre-screening of demands

Synergies With Other Projects And Programs

Interactions with international-level projects and initiatives

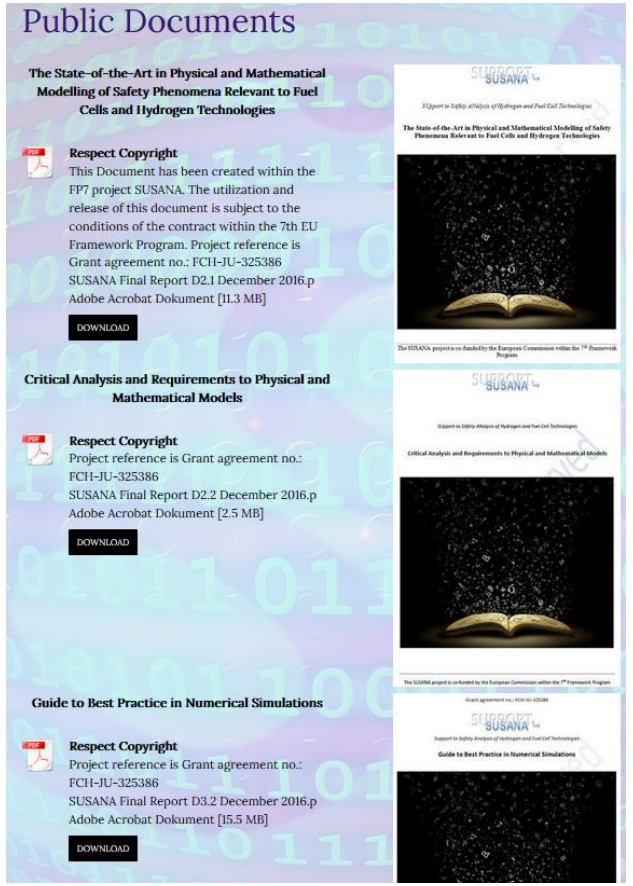
TeacHy — Teaching Fuel Cell and Hydrogen Science and Engineering Across Europe within Horizon 2020

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

FCHgo!

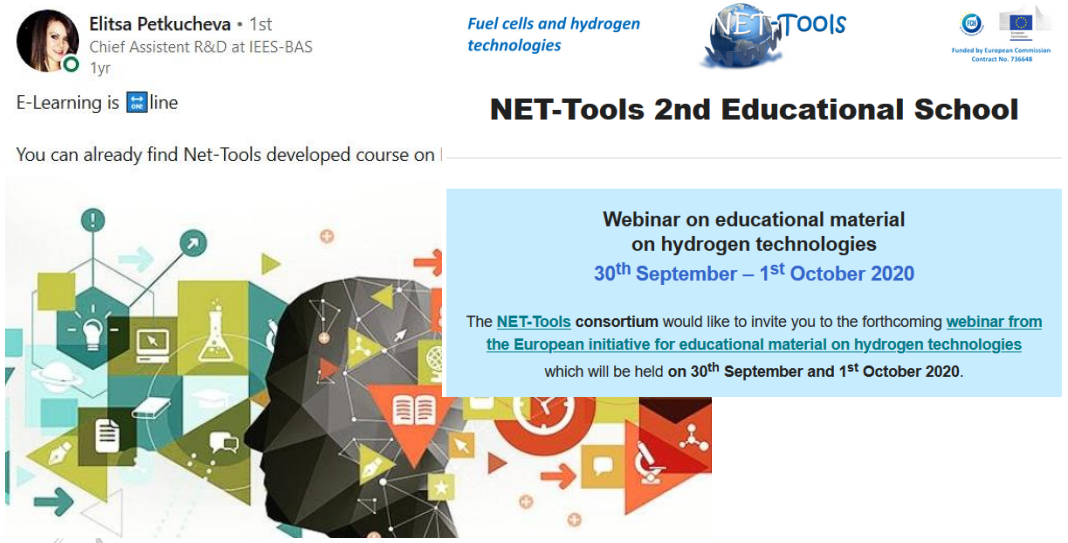
- Data Base for CFD modelling Hydrogen safety

SUPPORT SUSANA



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 on demand



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Thank you for your kind attention…stay tuned

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