NET-Tools

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

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Programme Review Days 2018

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PROJECT OVERIVEW

- **Call year:** 2016
- **Call topic:** H2020-JTI-FCH-2016-1; FCH-04-1-2016 Novel Education and Training Tools
- **Project dates:** 01.03.2017 – 28.02.2020
- **% stage of implementation 01/11/2018:** 45 - 55 %
- **Total project budget:** 1.596.007,50 €
- **FCH JU max. contribution:** 1.596.007,50 €
- **Other financial contribution:** not yet identified (*part of specific deliverable*: business plan)

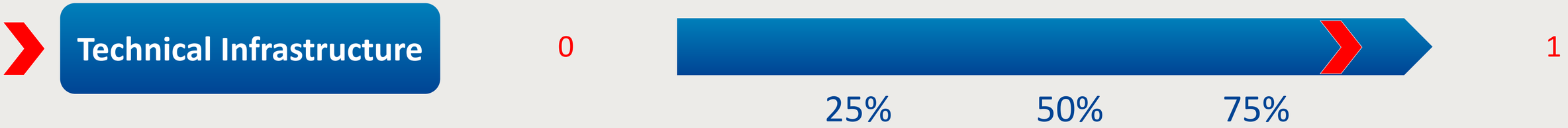
PROJECT OVERIVEW

- **Partners:**
- **Karlsruher Institute of Technology (*Germany*)** member HER
- **PersEE (*France*)** member HE
- **National Center for Scientific Research "DEMOKRITOS" (*Greece*)** member HER
- **University of Ulster (*United Kingdom*)** member HER
- **Danmarks Tekniske Universitet (*Denmark*)** member HER
- **Institute of Electrochemistry and Energy Systems (*Bulgaria*)** member HER
- **Universita Degli Studi di Perugia (*Italy*)** member HER
- **Element Energy Limited (*United Kingdom*)** member HE

PROJECT SUMMARY

- **NET-Tools**, *Novel Education and Training Tools based on digital applications related to Hydrogen and Fuel Cell Technology*
- **Objectives**
  - Education and training e-tools dedicated to FCH relevant themes (MAWP addendum 2018)
  - Education and training for students and professionals (MAWP addendum 2018, NIP)
  - Interaction and interconnection with relevant projects (MAWP, NIP)
  - Informal platform for any stakeholder, public, politicians (MAWP)
- **Global positioning vs international state-of the art**
  - Linchpin and network for FCH relevant educational materials and contents, practical e-tools, RCS (databases), PNR and safety aspects
- **Application and market area**
  - Education and training, provider of database and specific content, managing of lectures and schools (summer and winter schools), flying teachers

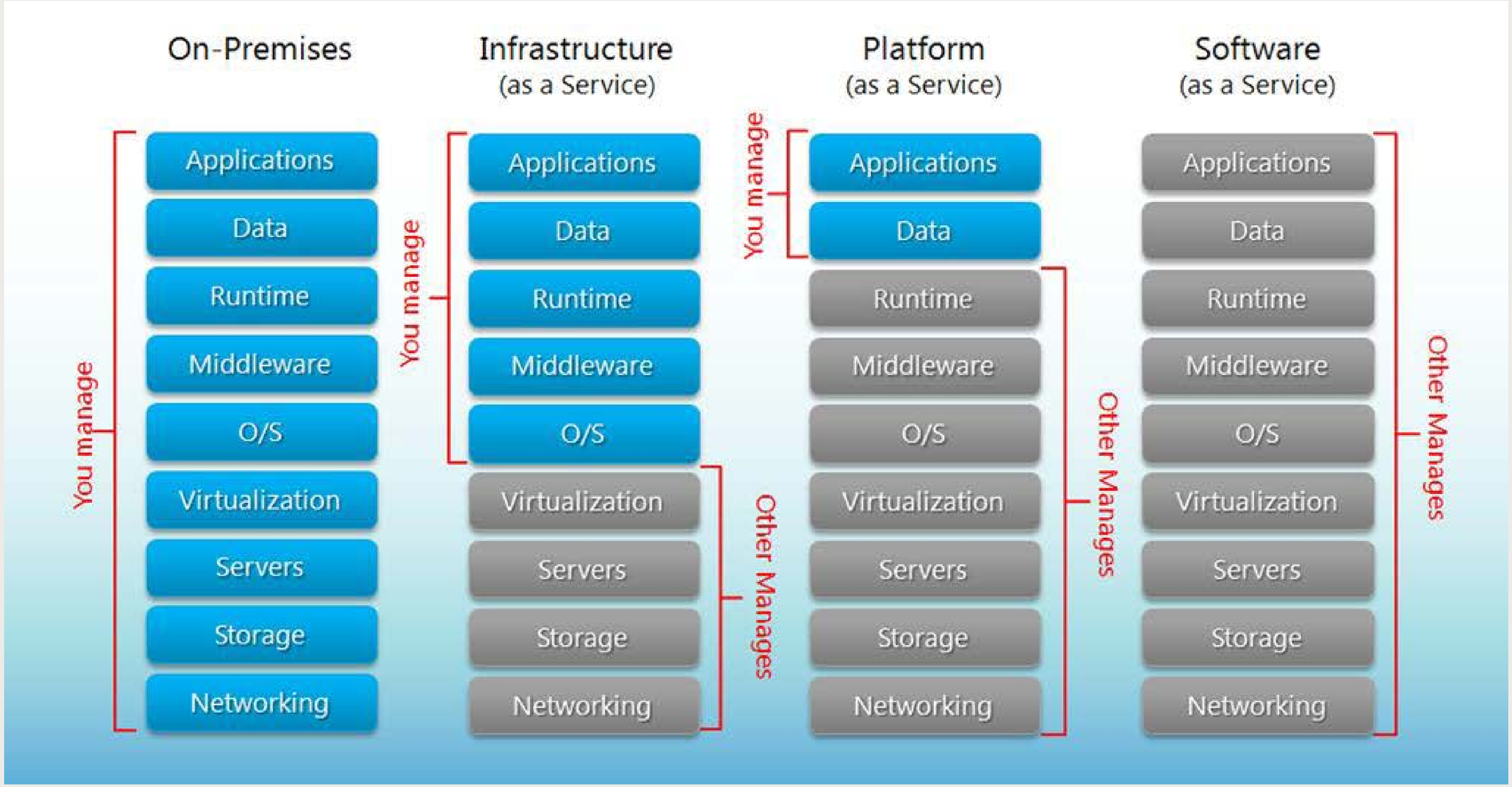
PROJECT PROGRESS/Technical Infrastructure



- **Open source based e-infrastructure** dedicated to FCH knowledge and science able to connect existing knowledge and easily integrate or support the development of new ones
  - Server based solution planned but discarded due to costs, practical maintenance and software updates
  - Project plan changed to implement e-learning and e-laboratory via approved open source platforms also cloud based
- **NET-Tools website** works as linchpin to interconnect all open source platforms and activities
  - Project plan changed to implement NET-website (runs as NET-platform) via approved open source platform
- Interfaces adapted (lectures and users) to different target audience, e.g. students and professionals (e-education)
- **Implementation of e-learning** platform (LMS) at open EdX
- **Implementation of digital e-laboratory** workspace (distinguished between e-science and e-engineering)
- Reinstallation of **databases** at NET-Tools website, e.g. SUSANA database

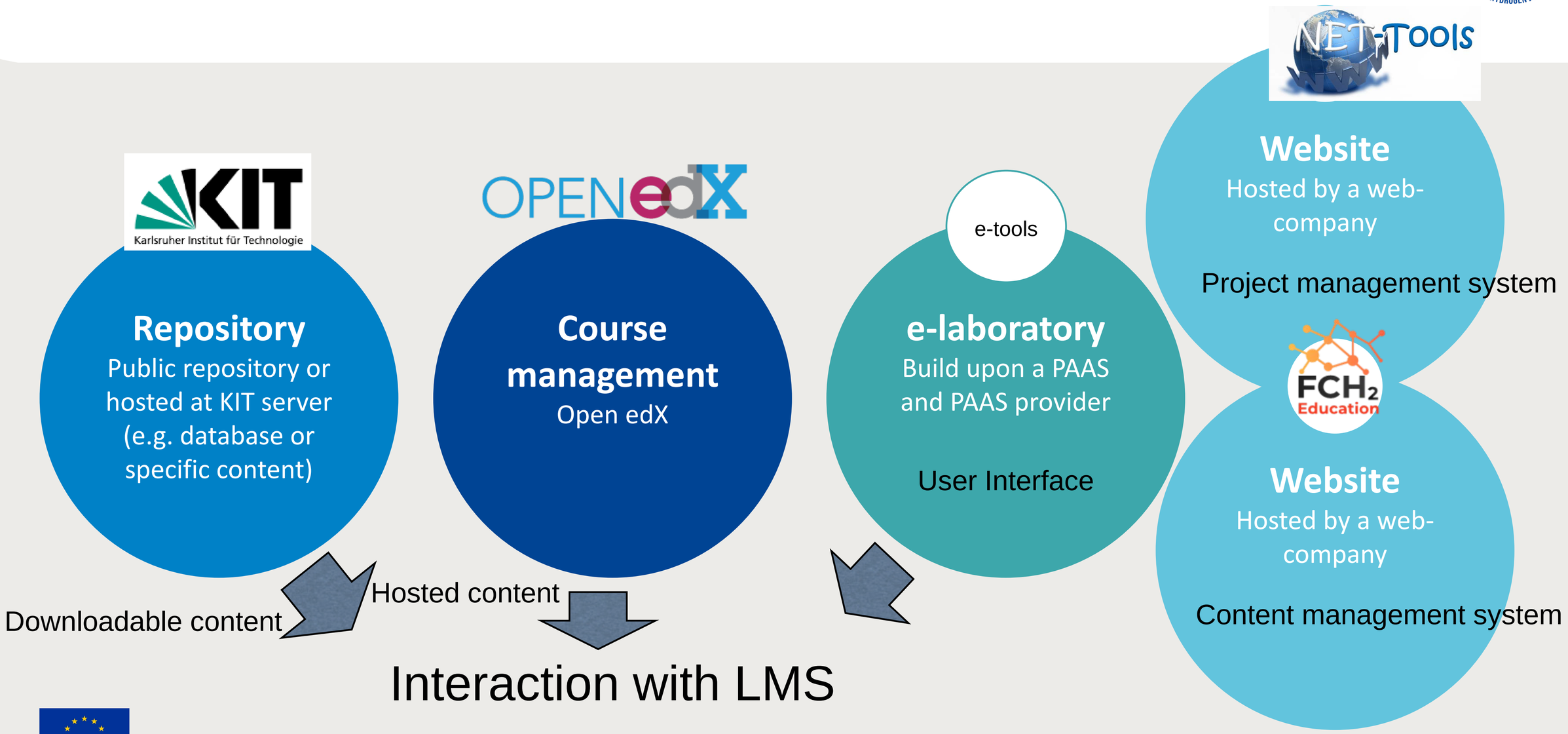
Technical Architecture and Composition

Overview of opportunities to the technical infrastructure



Practical Structure and Interconnection

Overview of opportunities to the technical infrastructure



PROJECT PROGRESS/Compiling and development of e-educational content materials and MOOCs

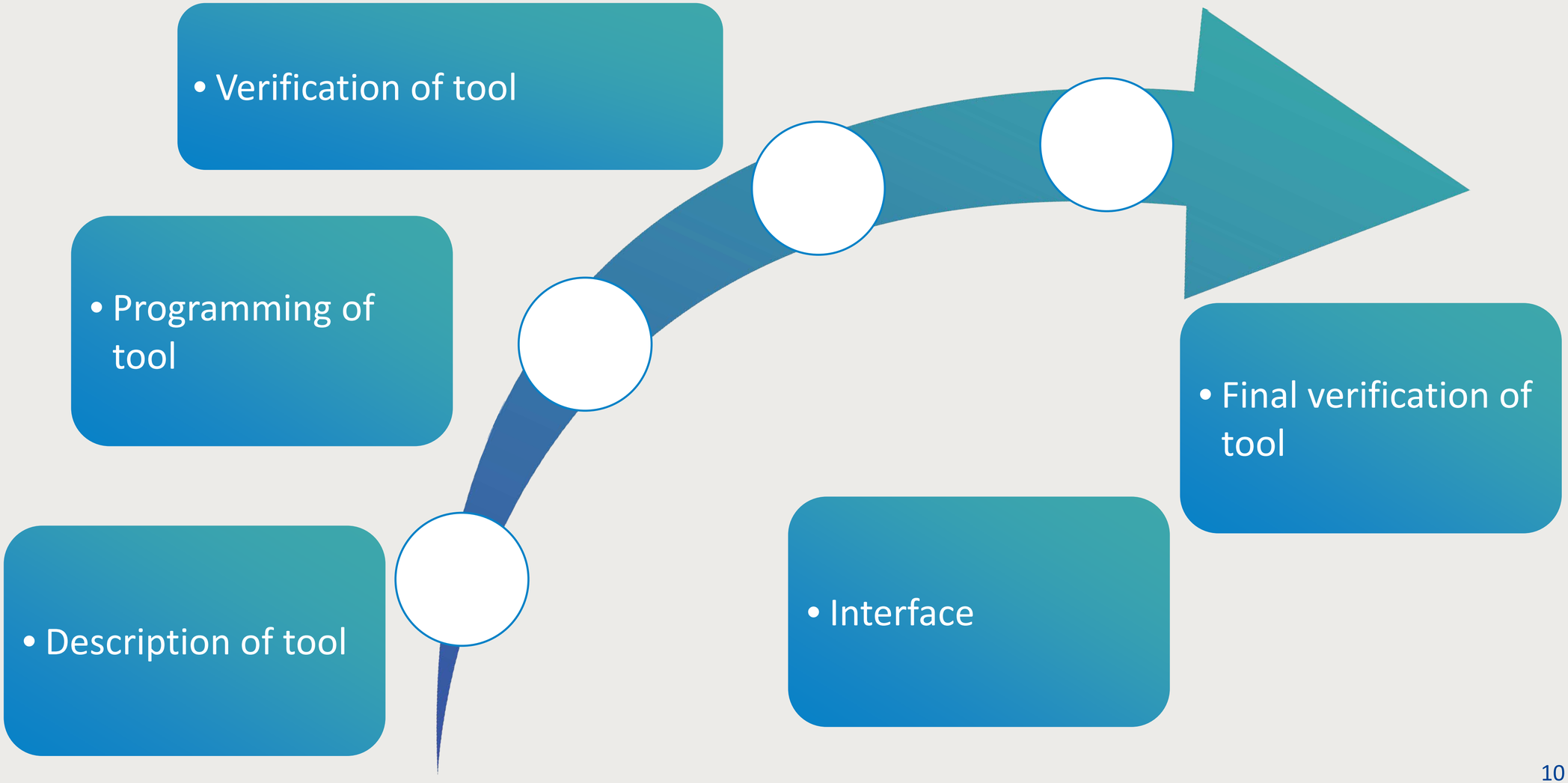
- **Consolidation of existing e-education** and e-knowledge (courses, lectures, modules)
  - Surprisingly less e-content (already provided under open access) could get investigated
  - **Demand** of providing e-learning materials must get investigated more detailed
  - **Quality assurance and IPR** to be implemented simultaneous to new engagements of external participants
- Three main **lectures planned** to be prepared as example course (e-learning content):
  - Use of Hydrogen (dedicated to Fuel Cells only)
  - Hydrogen Production (all methods including storage)
  - Hydrogen Handling (transportation etc.)
- Development of **novel training** delivery method together with new digital practices (interconnection with e-laboratory)
  - Strategy to follow up this academic pretension and targets less defined “how”
- **Engagement** with and gaining traction from the wide FCH community, companies and universities

PROJECT PROGRESS/Development of e-tools to the e-laboratory

- **Consolidation of existing e-tools** and e-knowledge
  - Surprisingly less e-content (already provided under open access) could get investigated
  - **Demand** of providing e-learning materials must get investigated more detailed
  - **Quality assurance and IPR** to be implemented simultaneous to new engagements of external participants
- **e-laboratory** distinguished in:
  - **e-engineering tools** (for practical teaching and learning and pre-evaluation)
  - **e-science tools** (to support research e.g. modelling and simulation)
- **Engagement** with and gaining traction from the wide FCH community, companies and universities

Procedure and Structure Development of e-tools

Development of e-laboratory and e-Tools



Planning of e-tools

Graphic to demonstrate complexity of development (not to read in details)

		Tools	Description	Programming	Verification	Interface	Final verificat
e-Laboratory	e-Engineering	Renewable energy system (RES) tools	1. Design & Optimisation of hybrid RES – Hydrogen autonomous power systems for isolated communities and sites.	NCSRD M18	NCSRD M18	NCSRD M19	M20	NCSRD M20
		Fuel cells (FC) tools	1. Simulation of SOFC based on natural gas as fuel	DTU M23(12,7)	M24	M14	M15	M25
			2. Energy balances and hydrogen costs for various electrolysis techniques	DTU M25(11,6)	M26	M13	M14	M27
			3. Cell and stack models for both fuel cells and electrolysis	DTU M15(10,5)	M16	M12	M13	M17
			4. Thermo-mechanical models to predict lifetime of high temperature FCs and electrolysis	DTU M19(9,4)	M20	M11	M12	M21
		Storage/Separation tools	1. Storage material properties estimation and performance assessment based on a "materials-by-design" multi-scale approach; a. Hydrogen Storage in Carbon-based Materials, b. Hydrate equilibrium pressure of H2 mixtures, c. Hydrate-based separation of the binary mixture H2+CO2	NCSRD M12	NCSRD M16(12)	NCSRD M17(13)	M17(14)	M18(14)
		FC integrated into CHP tools	1. Simulation of FC system integrated into mCHP application, including electrolyser operation	UNIPG M2	M4	M8	M10	M10
		Safety engineering tools	1. Jet parameters model	UU M2	M7	M8	M10	M10
			2. Adiabatic and isothermal model of blowdown of storage tank dynamics	UU M2	M8	M9	M10	M10
			3. Flame length correlation and three hazard distances for jet fires	UU M3	M8	M9	M10	M10
			4. Similarity law for concentration decay in hydrogen expanded and under-expanded jets and unignited jet hazard distances	UU M4	M9	M10	M11	M11
			5. Pressure peaking phenomenon for unignited releases	UU M3	M9	M10	M11	M11
			6. Passive ventilation in an enclosure with one vent: uniform hydrogen concentration	UU M1	M4	M6	M10	M10
			7. Mitigation of uniform mixture deflagration by venting technique	UU M4	M14	M15	M16	M15
			8. Forced ventilation system parameters	UU M5	M15	M16	M16	M17
			9. Blast wave from high-pressure rupture without and with combustion	UU M14(12,10)	M15	M16	M16	M17
			10. Effect of buoyancy on decrease of hazard distance for unignited releases	UU M6	M10	M11	M12	M12
			11. Pressure peaking phenomenon for ignited releases	UU M6	M17	M18	M18	M18
			12. Upper limit of hydrogen inventory in closed space	UU M7	M8	M9	M10	M10
			13. Mitigation of localised non-uniform deflagration by venting	UU M8	M16	M14	M15	M15
			14. Effect of buoyancy on hazard distances for jet fires	UU M14(12,8)	M15	M16	M17	M17
			15. Calculation of fireball diameter for rupture in a fire of a stand-alone and an under-vehicle hydrogen storage tanks	UU M9	M14	M15	M16	M16
			16. H2 properties and Tank Blowdown	NCSRD M24	NCSRD M24	NCSRD M25	M26	NCSRD M26
		Property tools	~~1. Normal Hydrogen thermo-physical properties using the NIST-EoS, (Helmholtz free energy based)~~	~~NCSRD M17~~	~~NCSRD M17~~	~~NCSRD M18~~	~~M19~~	~~NCSRD M19~~
			2. The Abel-Noble EOS to calculate CGH2 mass in a volume at particular pressure and density	UU M9	M16	M17	M18	M18
		Electrochemistry tools	1. Fundamental electrochemistry equations, design PEM, optimal porosity of gas diffusion electrodes, ionic conductivity: a. Electrochemical potential; b. Nernst equation; c. Faraday laws of electrolysis; d. Butler-Volmer equation; e. Tafel equation; f. Ionic conductivity g. Levich equation	IEES M4	M17	M18	M19	M19
	e-Science	Storage tools	1. Comsol Multiphysics for simulation of hydrogen production and FCH technologies; a. Methane steam reformer; b. Solid Oxide Fuel Cell (SOFC)	NCSRD M12	NCSRD M12	NCSRD M13	M14	NCSRD M14
		FC tools	1. Modelling of transport processes in electrodes and electrolytes:	DTU M21(12,4)	M22	M18	M19	M23
		HyFOAM	1. Release and dispersion of horizontal under-expanded hydrogen jet (HSL)	UU M13	M17	M18	M18	M18
			2. Large scale deflagration in the open atmosphere (Fraunhofer ICT)	UU M16	M16	M18	M18	M18
			3. Blast wave and fireball from high-pressure tank rupture in a fire (Weyandt)	UU M25	M25	M27	M27	M27
			4. Hydrogen/helium dispersion in vented enclosures (CEA)	NCSRD M17	M17	M19	M19	M19
			5. Vented deflagration (FM Global)	NCSRD M26	M26	M27	M27	M27

Risks and Challenges

Major Risk (during project)

- Keep educational materials attractive
- Hold the lines to external participants and instructions (guidelines)
- Quality assurance and content management
- Intellectual property rights

Major Risks (beyond the project)

- Running empty of resources to operate and maintain NET-Tools platform
- To cover expenses of running platform especially LMS at EdX open source
- Insurance of quality to the content, visibility and support to content providers and users

Communications Activities

Expert Workshop

Project Flyer

Project Website

Project e-Newsletter 3rd Issue

List of potential Stakeholders

Social Media

Visit us:

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 736648.
This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research.

Educational Schools

Flying Teachers

Publications

Communications Activities

Czech Hydrogen Days Prague 2018

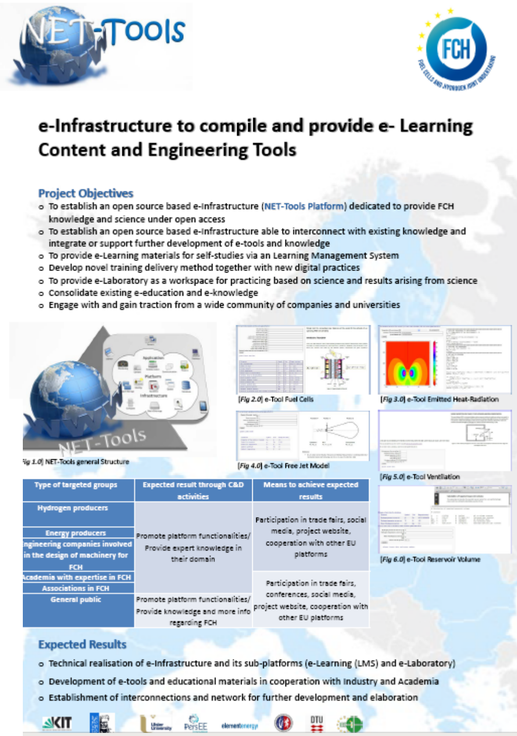
ECF Naples 2017

Expert Workshop Trentino 2018

EHEC Malaga 2018

WHEC Rio de Janeiro 2018

Hands on Training Webinar 2018



Collaboration Activities

HySafe

Herve Barthelemy, Thomas Jordan, Marco Carcassi, Jay Keller
International Association for Hydrogen Safety HySafe

The focal point on integrated research and information for hydrogen safety

Czech Hydrogen Days 2018
Praha 13/15 June 2018

UNIVERSITY OF BIRMINGHAM

New Programme of Study and e-Learning Tools for Educating in Fuel Cell and Hydrogen Technologies

TeacHy

Robert Steinberger-Wilckens
Centre for Fuel Cell & Hydrogen Research
University of Birmingham

EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation

- NET-Tools as open access

- Newsletters, flyers and presentations on respective events

- Educational Schools (demonstrative)

- Workshops and communication to raise engagements

Impact

- European linchpin to educational materials and content on different level

- Online education and training of e.g. engineers and technicians

- e-tools for pre-evaluation and calculation of project realization

- Database and collection of knowledge

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