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# TEACHING FUEL CELL AND HYDROGEN SCIENCE AND ENGINEERING ACROSS EUROPE

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# TEACHING FUEL CELL AND HYDROGEN SCIENCE AND ENGINEERING ACROSS EUROPE

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TUBA World Conference on  
**Energy Science and Technology**

(TUBA WCEST-2021) ● August 8-12, 2021 / Online



TeachHy is a project funded by the Horizon 2020 program through FCH JU.

The offers its network partners access to its educational material and the use of the MSc course modules available on the TeachHy web site.

There are **12 partners** from **11 European countries**. Until this moment the partners contributed together to the realization of 20 didactical modules.

## Partners



UNIVERSITY OF  
BIRMINGHAM



Technical  
University of  
Denmark



**The project**, entitled: *Teaching Fuel Cell and Hydrogen Science and Engineering Across Europe within Horizon 2020*, acronym *TeachHy*, **is addressed to universities that have master's courses** covering elements related to hydrogen economics and the benefits that will be obtained by implementing it. Also, the **deliverables** generated by the project are intended to be **useful tools for teachers** in various European universities, which deal with the implementation of hydrogen in the renewable energy and alternative fuels, so that **the number of students, PhD students and specialists** with up-to-date knowledge in this field, to be **bigger and bigger**.

## The partners have prepared:

- 7 compulsory (mandatory) modules,
- 11 optional modules, and
- 2 additional modules.



## Compulsory modules:

1. Thermodynamics, electrochemistry, chemistry (KIT)
2. Characterisation methods (EPFL)
3. Introduction to fuel cells (UBHAM)
4. Fuel cell modelling tools (POLITO, Grenoble INP) and control (TUD)
5. Hydrogen (production, storage, handling), fuels (P2G, P2X) (UPB), electrolyzers (UCTP, Grenoble INP)
6. Labs (POLITO)
7. Hydrogen safety (UU)

## Optional modules:

1. Environmental analysis, life cycle analysis (UBHAM)
2. Low temperature fuel cells (materials, stacks, thermodynamics, electrochemistry, chemistry) (Grenoble INP, UCTP, DTU)
3. High temperature fuel cells (materials, stacks, thermodynamics, electrochemistry, chemistry) (TUD, KPI)
4. Low temperature systems (DTU)
5. High temperature systems (UBHAM)
6. Advanced characterisation (EPFL)
7. High temperature chemistry for SOFCs/SOEs (TUD, KPI)
8. Fuel cell electric vehicles (UBHAM)
9. Politics, markets, regulation, codes and standards (UBHAM, ULB)
10. Energy system and storage (UPB)
11. Advanced modelling (POLITO, Grenoble INP)



In order to create a didactic content you must understand and know the evolution of the didactic tools.



... is about the evolution from **tablet** to **tablet**

# creating online content

it seem simple ....

you document yourself

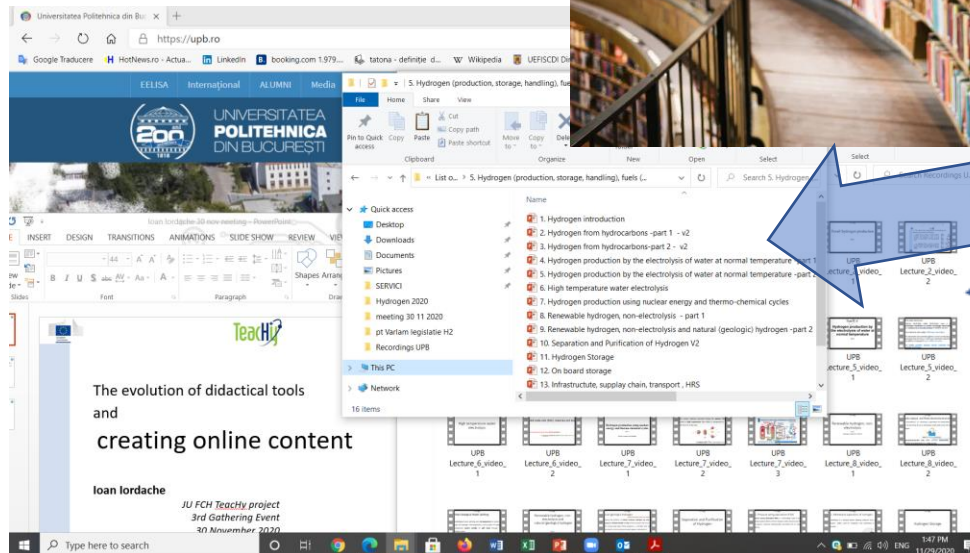
....upload data in

.....your laptop

classic



internet



... the course is ready!

# Examples of didactical content:

## 1. Steam reforming for hydrogen production

- Steam methane reforming (SMR) - is the most common method of producing commercial bulk hydrogen.
- Hydrogen is an important raw material for the **chemical, petrochemical** or **agrochemical** industry, with the big chances to become an **energy carrier alongside electricity** in the near future.

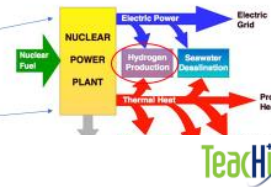


## 3. Hydrogen production with nuclear energy

There are two main **energy source** that can be used from **nuclear power**

plants to produce hydrogen:

- **electricity** and
- **heat.**



Renewable hydrogen, non-electrolysis and natural (geologic) hydrogen

Part 2

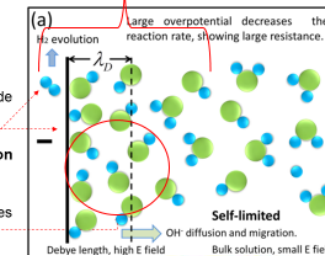
- Hydrogen production methods—summary
- Natural (geologic) hydrogen

Renewable hydrogen, non-electrolysis

## 2. Theory of water electrolysis. Thermodynamics

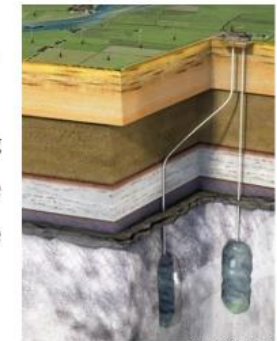
- The water electrolysis reactions are:

- (1) **heterogeneous**,
- (2) taking place at the **boundary between** the electrode and the electrolyte with
- (3) the aqueous boundary layer subject to **concentration and electrical potential gradients** with
- (4) the presence of the **generated gaseous nanobubbles** and microbubbles.



## Hydrogen underground storage

- Hydrogen as a mean to store energy.
- Increasing production of fluctuating renewable energy intensifies the **need for energy storage** to ensure network reliability and flexibility.

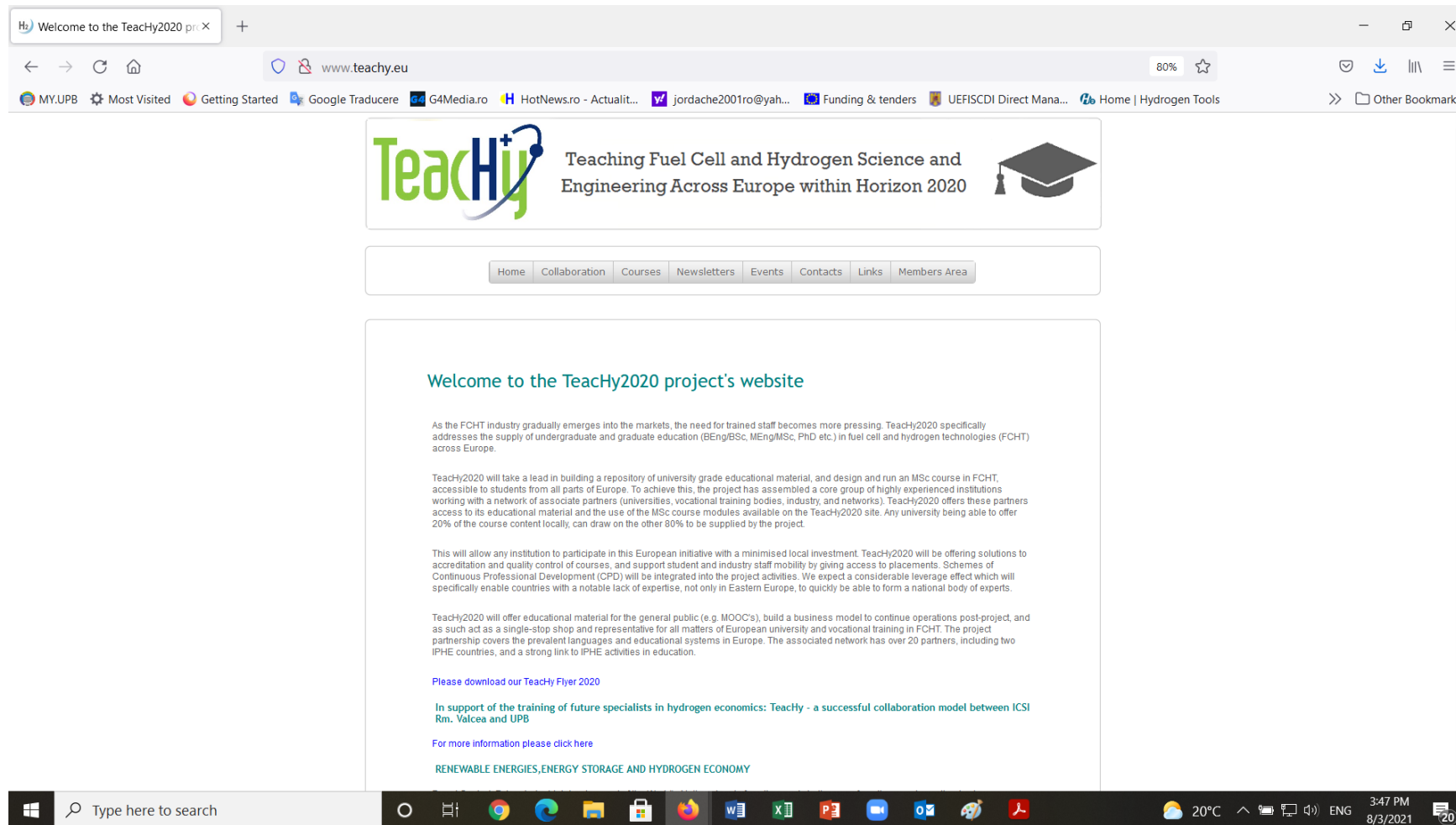


Hydrogen Infrastructure

Sources: KBB, Hydrogen

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More on  
<http://www.teachy.eu>



The screenshot shows a web browser window displaying the TeachHy2020 project website. The browser's address bar shows the URL [www.teachy.eu](http://www.teachy.eu). The website header features the TeachHy logo and the text "Teaching Fuel Cell and Hydrogen Science and Engineering Across Europe within Horizon 2020". Below the header is a navigation menu with links: Home, Collaboration, Courses, Newsletters, Events, Contacts, Links, and Members Area. The main content area is titled "Welcome to the TeachHy2020 project's website" and contains several paragraphs of text. The first paragraph states that the FCHT industry is emerging, and the project addresses the need for trained staff by supplying undergraduate and graduate education. The second paragraph describes the project's goal of building a repository of educational material and running an MSc course. The third paragraph mentions the project's focus on accreditation, quality control, and student/industry staff mobility. The fourth paragraph details the project's offer of educational material to the general public and its role as a single-stop shop for European university and vocational training. At the bottom of the main content area, there are three links: "Please download our TeachHy Flyer 2020", "In support of the training of future specialists in hydrogen economics: TeachHy - a successful collaboration model between ICSI Rm. Valcea and UPB", and "For more information please click here". The footer of the website reads "RENEWABLE ENERGIES, ENERGY STORAGE AND HYDROGEN ECONOMY". The browser window also shows a taskbar at the bottom with various application icons and system status information.

Welcome to the TeachHy2020 project's website

As the FCHT industry gradually emerges into the markets, the need for trained staff becomes more pressing. TeachHy2020 specifically addresses the supply of undergraduate and graduate education (BEng/BSc, MEng/MSc, PhD etc.) in fuel cell and hydrogen technologies (FCHT) across Europe.

TeachHy2020 will take a lead in building a repository of university grade educational material, and design and run an MSc course in FCHT, accessible to students from all parts of Europe. To achieve this, the project has assembled a core group of highly experienced institutions working with a network of associate partners (universities, vocational training bodies, industry, and networks). TeachHy2020 offers these partners access to its educational material and the use of the MSc course modules available on the TeachHy2020 site. Any university being able to offer 20% of the course content locally, can draw on the other 80% to be supplied by the project.

This will allow any institution to participate in this European initiative with a minimised local investment. TeachHy2020 will be offering solutions to accreditation and quality control of courses, and support student and industry staff mobility by giving access to placements. Schemes of Continuous Professional Development (CPD) will be integrated into the project activities. We expect a considerable leverage effect which will specifically enable countries with a notable lack of expertise, not only in Eastern Europe, to quickly be able to form a national body of experts.

TeachHy2020 will offer educational material for the general public (e.g. MOOC's), build a business model to continue operations post-project, and as such act as a single-stop shop and representative for all matters of European university and vocational training in FCHT. The project partnership covers the prevalent languages and educational systems in Europe. The associated network has over 20 partners, including two IPHE countries, and a strong link to IPHE activities in education.

[Please download our TeachHy Flyer 2020](#)

[In support of the training of future specialists in hydrogen economics: TeachHy - a successful collaboration model between ICSI Rm. Valcea and UPB](#)

[For more information please click here](#)

RENEWABLE ENERGIES, ENERGY STORAGE AND HYDROGEN ECONOMY



# Our role as professors does not change!

...**but** the digitalization means a lot more, instead of assistants or PhD students, we would rather need actors, someone(or more) with a pleasant voice, TV operators, ... ... finally a full TV team from Discovery!



What is a pen, notebook or pencil box?  
Yes, our generation know!



Thank you for your attention!

.... but how many of us know how to use a quill pen?