



Hydrogen handling R&D initiatives at University in Turin



What is behind
the scenes?

Find out H2
labs,
researchers,
and facilities in
Piedmont

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University of Turin

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Ludovico
di Savoia
1404

Research and technology transfer (2020)



over **600** projects presented
in competitions

33 registered patents (2017-19)

over **8,400** academic publications
(2019)*

over **500** junior researchers

3rd in Italy with **10** departments
selected by the Italian Ministry of
Education, University and Research
(MIUR) as "Departments of Excellence"

over **€ 15 million** earned through
research and consultancy activities

Students (AY 2020/21)



over **81,700** students

61,6% women

23,3% from outside Piedmont
Region

about **4,900** students with foreign
nationality (**6% of total**)

about **900** disabled students

about **2,000** students with
specific learning disability (SLD)

about **26,000** first-year students of
which **5,4%** students with **foreign
nationality**

over **760** students enrolled on masters –
1st and 2nd level

over **1,100** PhD students (as of
31/12/2019)

Staff (as of 31st December 2020)



Academic Staff

472 Professors

924 Associate Professors

660 Lecturers

Women **43%**

Administrative Staff

1,730 permanent employees

119 fixed-term employees

Women **69%**

Among the **top 300** Universities
worldwide and **4th** in Italy, for
ARWU Shanghai

217th worldwide for **US News**
Best Global Universities

178th worldwide and **5th** in Italy for
NTU Taiwan

22nd worldwide and **2nd** in Italy
for **Greenmetric** universities sustainability
ranking



ILLUSTRIOUS ALUMNI AND TEACHERS

The first famous graduate: **Erasmus of Rotterdam, 1506**



Famous scientists and leading personalities who were students or teachers here throughout the centuries:

L. Lagrange, A. Avogadro, A.L. Cauchy, S. Cannizzaro, A. Sobrero, G. Peano, A. Gramsci, P. Levi, C. Pavese, P. Gobetti, P. Togliatti, N. Bobbio

Nobel Prize laureates:

S. E. Luria, R. Dulbecco, R. Levi Montalcini

Heads of State: **L. Einaudi, G. Saragat.**





UNIVERSITÀ DEGLI STUDI DI TORINO

School of Agriculture and Veterinary Medicine - SAMEV

School of Human Sciences

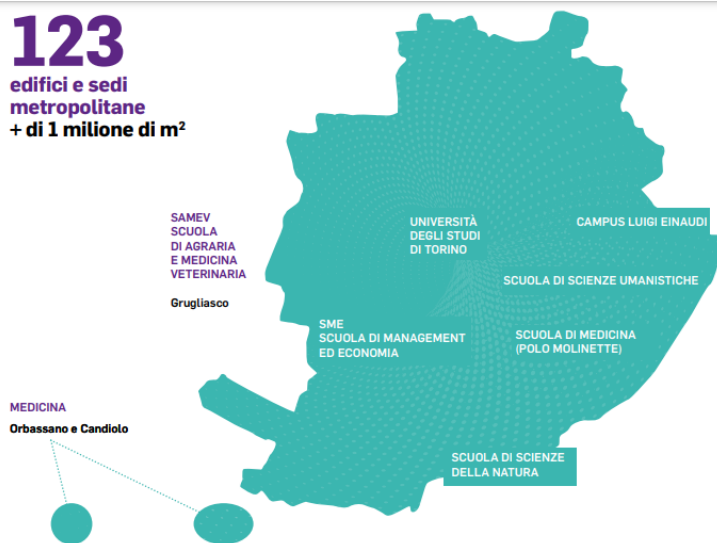
School of Law, Politics and Social-Economic Sciences

School of Management and Economics

School of Medicine

School of Science of Nature

123
edifici e sedi
metropolitane
+ di 1 milione di m²



Department of Agricultural, Forest and Food Sciences

Department of Chemistry

Department of Clinical and Biological Sciences

Department of Computer Science

Department of Cultures, Politics and Society

Department of Drug Science and Technology

Department of Earth Sciences

Department of Economic, Social, Mathematical and Statistical Sciences

Department of Economics and Statistics "Cognetti de Martiis"

Department of Foreign Languages, Literatures and Modern Cultures

Department of Historical Studies

Department of Humanities

Department of Law

Department of Life Sciences and Systems Biology

Department of Management

Department of Mathematics "Giuseppe Peano"

Department of Medical Sciences

Department of Molecular Biotechnology and Health Sciences

Department of Neurosciences "Rita Levi Montalcini"

Department of Oncology

Department of Philosophy and Education Sciences

Department of Physics

Department of Psychology

Department of Sciences of Public Health and Pediatrics

Department of Surgical Sciences

Department of Veterinary Sciences

Interuniversity Department of Regional and Urban Studies and Planning

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DI TORINO

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TAURINENSIS

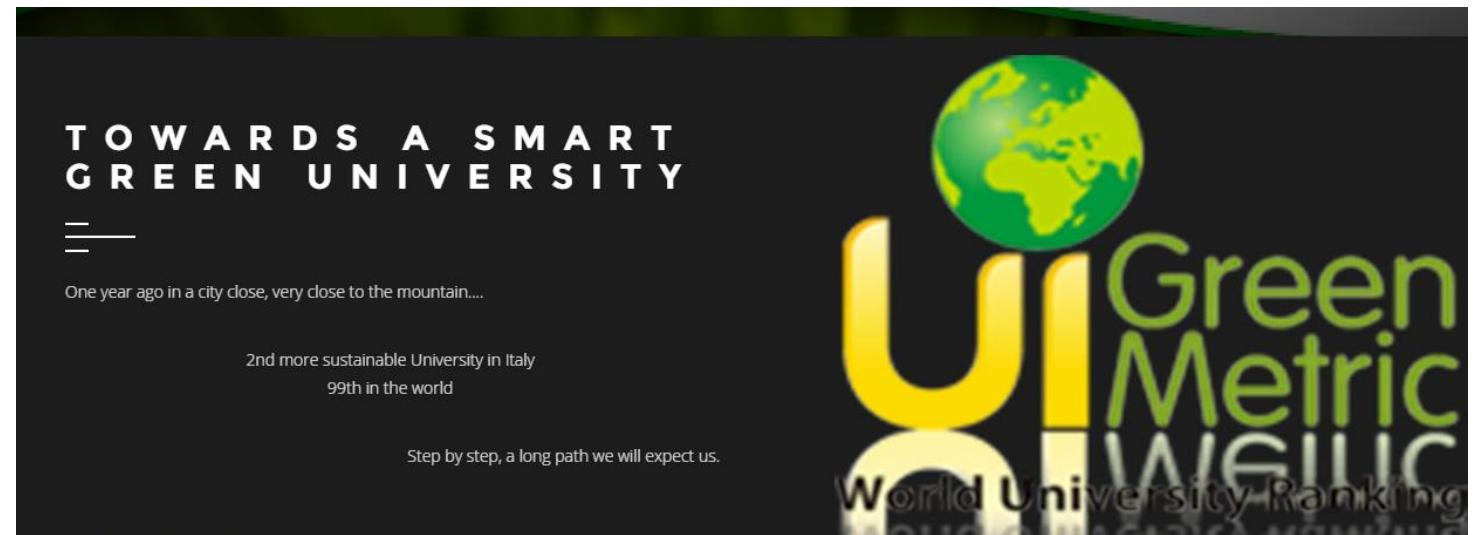


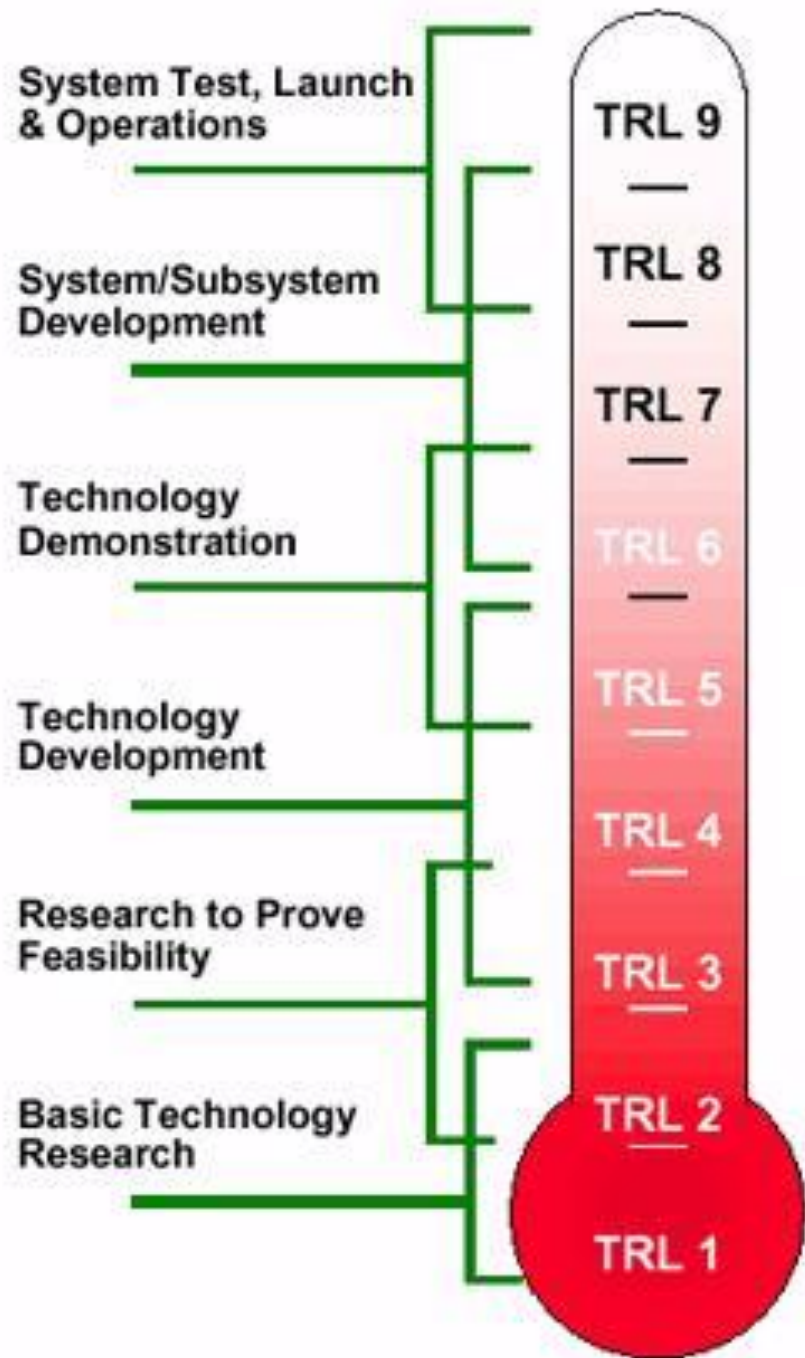
UniToGO

UNIVERSITÀ DI TORINO
GREEN OFFICE

www.green.unito.it

2nd more sustainable University in Italy
41st in the world





IL **INDUSTRIAL
LIAISON
OFFICE**
UNIVERSITÀ DI TORINO

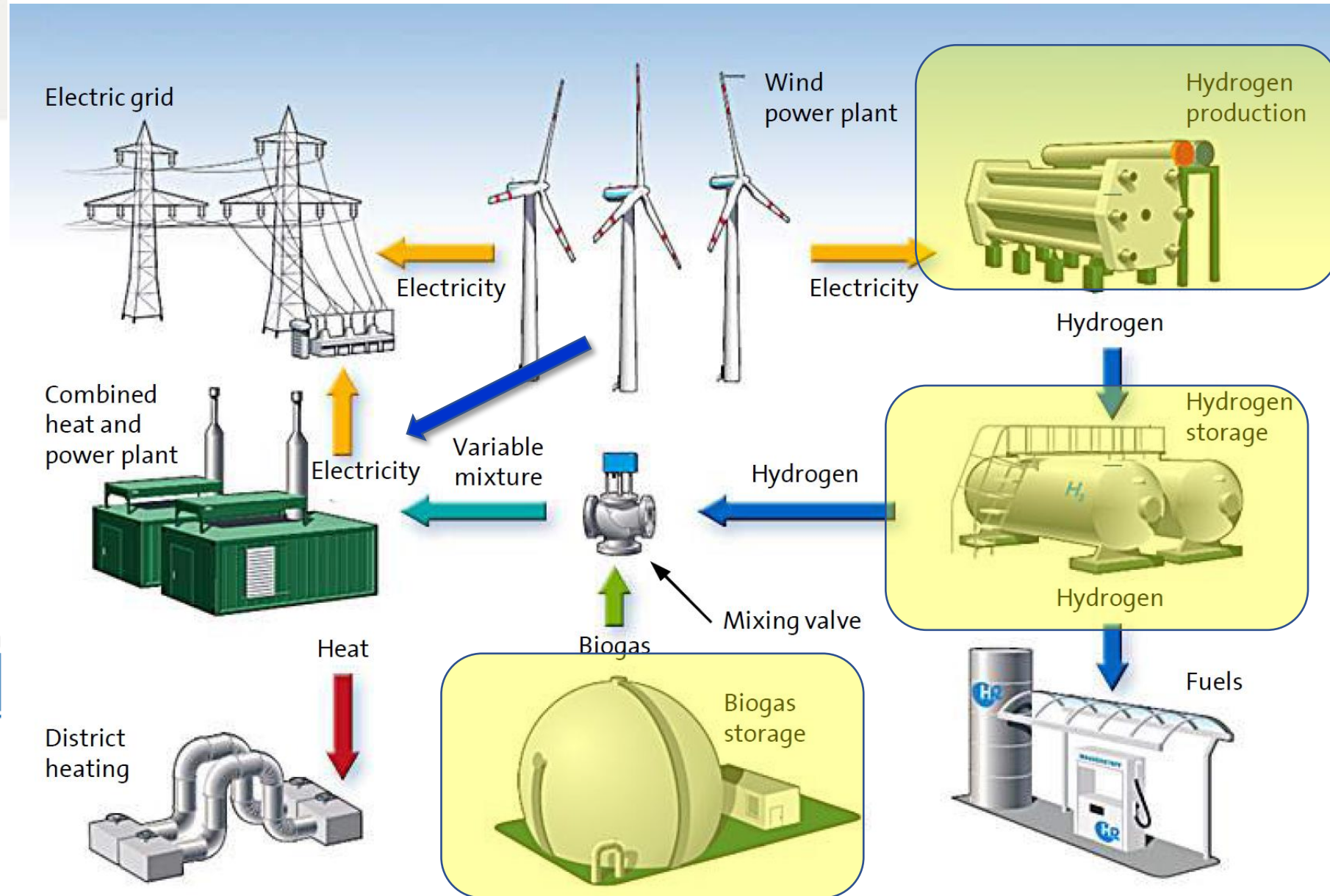


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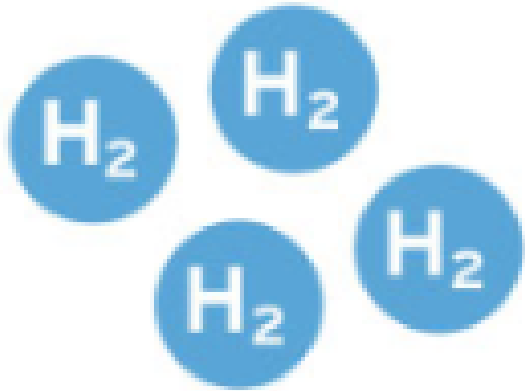


Green hydrogen from renewables





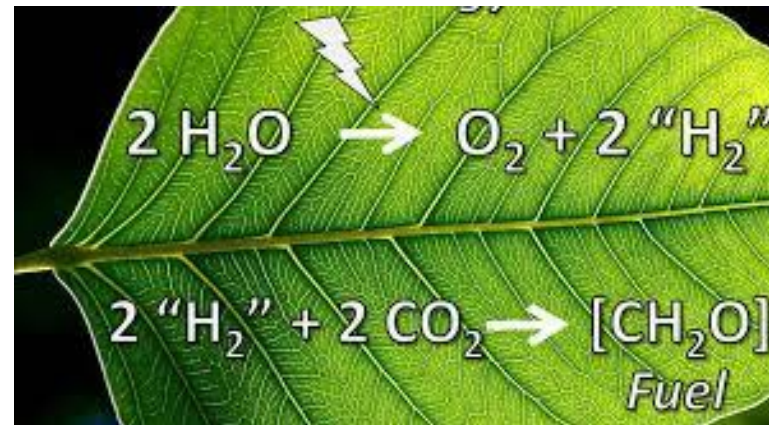
Hydrogen handling



- **Production**
- **Storage**
- **Transportation**
- **Purification**
- **Compression**
- **Use**
- **Acceptance**

Hydrogen production

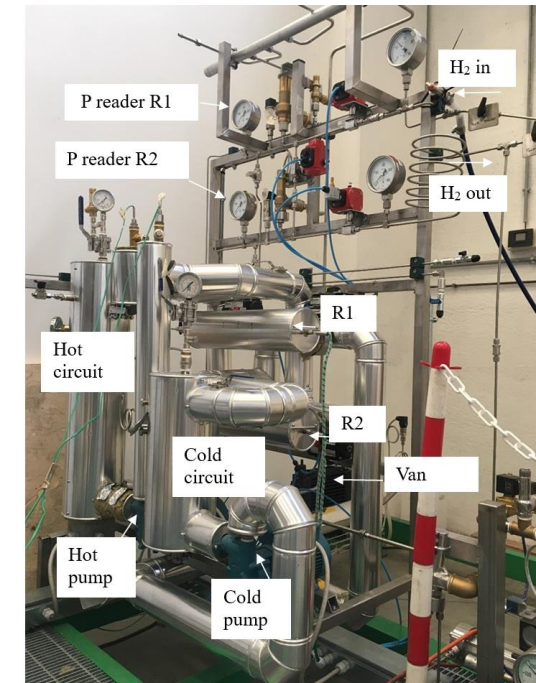
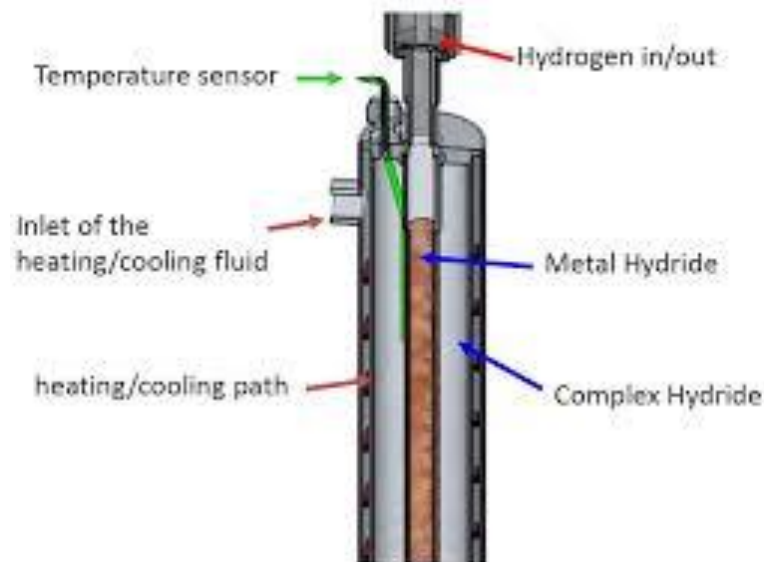
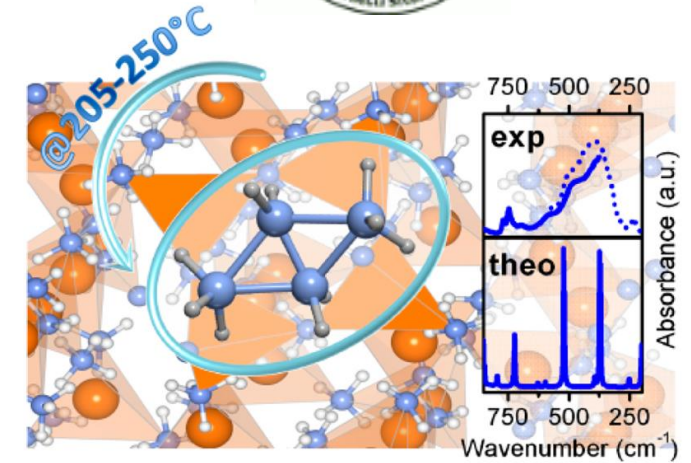
- Biomasses (bacteria, algae) hydrogenase enzymes
- Catalysts for water electrolysis
- Photo-activated water splitting.



Hydrogen storage

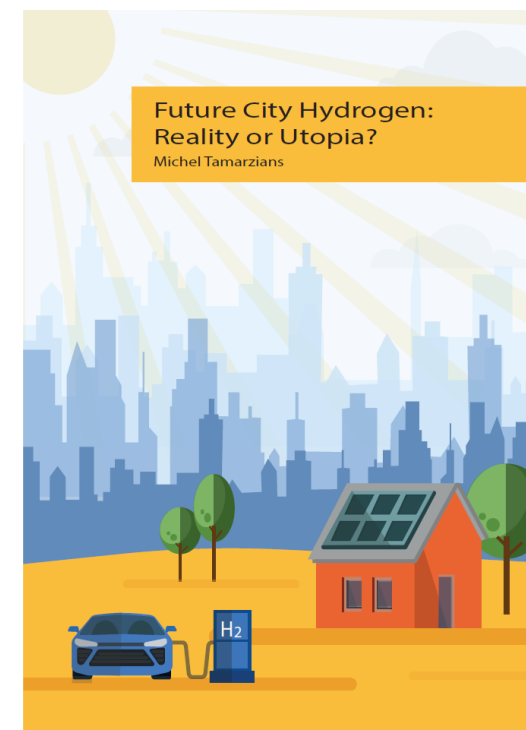
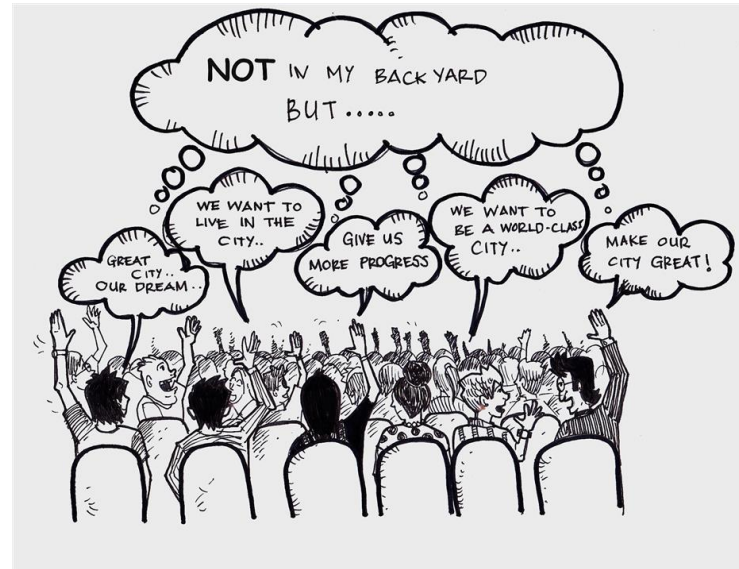


- Underground hydrogen storage
- Solid-state hydrogen carriers
- Hydrides for energy storage
- Hydrogen compression and distribution
- LCA of hydrogen storage and compression

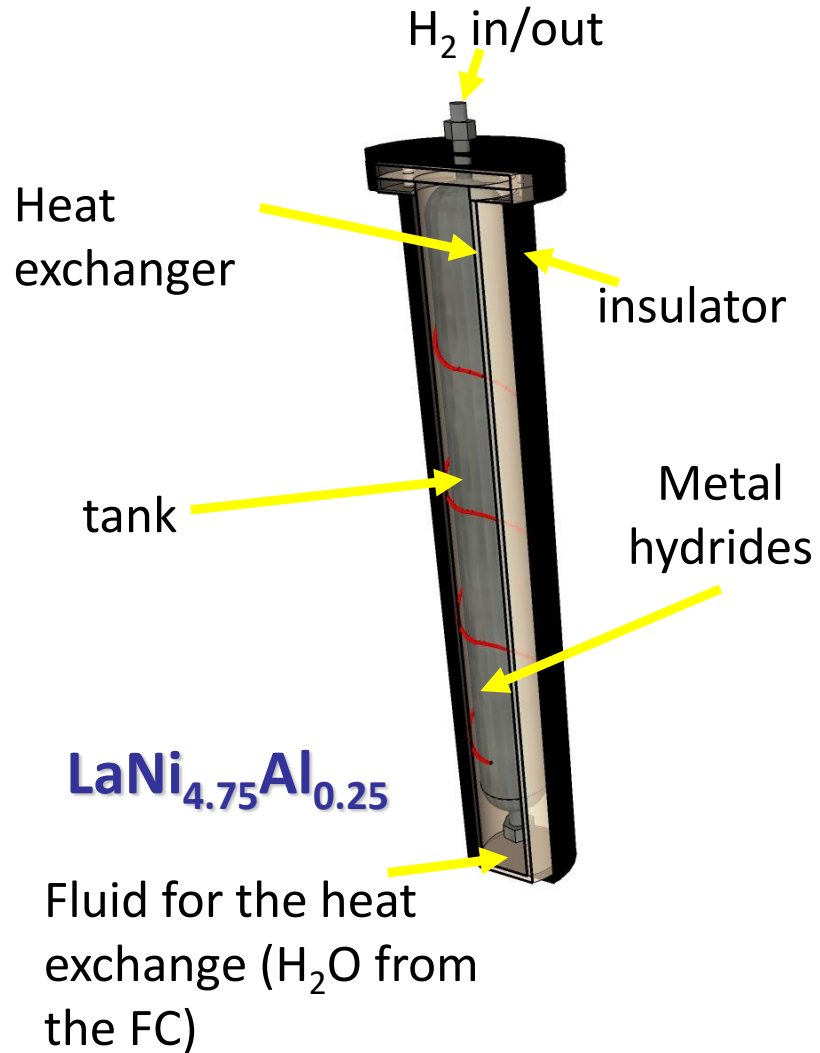


Hydrogen management

- Business-case for hydrogen technologies
- Normatives, incentives and regulations
- Social acceptance of hydrogen technologies



Integrated FC system



m'illumino
di meno

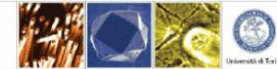


The main hall of the Chemistry Department of UniTo was enlightened for 4 h by using the energy produced by the integrated system

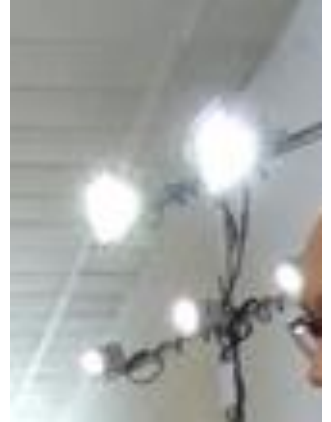


APU installed on IVECO Daily

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**H2 storage tank based on the
combo materials approach**



M.Baricco. et al. , J. Power Sources 342 (2017) 853



Contents lists available at ScienceDirect

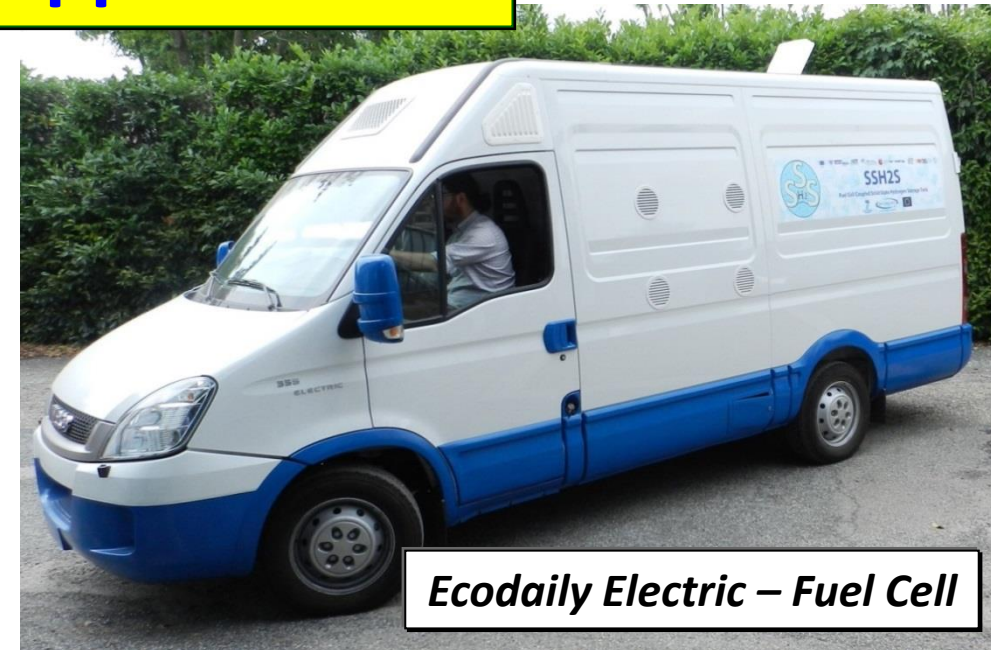
Journal of Power Sources

journal homepage: www.elsevier.com/locate/jpowsour



SSH2S: Hydrogen storage in complex hydrides for an auxiliary power unit based on high temperature proton exchange membrane fuel cells

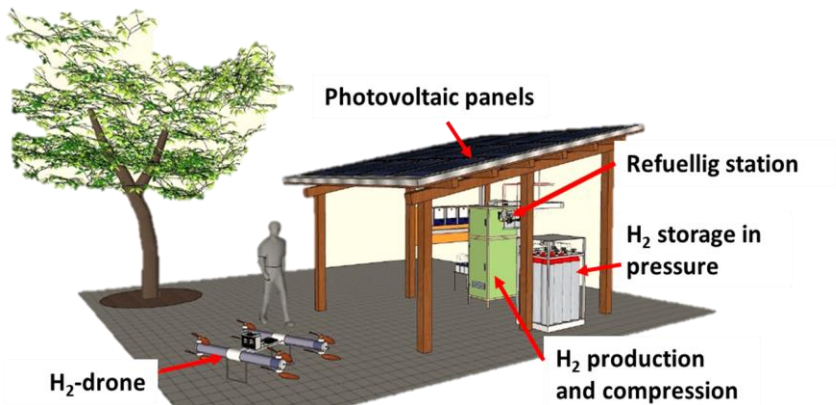
Marcello Baricco^a, Mads Bang^b, Maximilian Fichtner^c, Bjorn Hauback^d, Marc Linder^e, Carlo Luetto^f, Pietro Moretto^g, Mauro Sgroi^{h,*}



Ecoday Electric – Fuel Cell

Clean-DronHy: H₂ powered drone with H₂ refuelling station

➤ GOAL: produce, compress and use H₂ onsite



H₂-REFUELLING STATION

- **Photovoltaic** panel: 10 panel of 300 W
- **Electrolyser** EL-250 by Enapter: 250 NI/h of H₂ at 30 bar and Tamb
- **MH-Compressor**: output pressure of 200 bar
- **Booster**: from 200 to 400 bar

DRONE

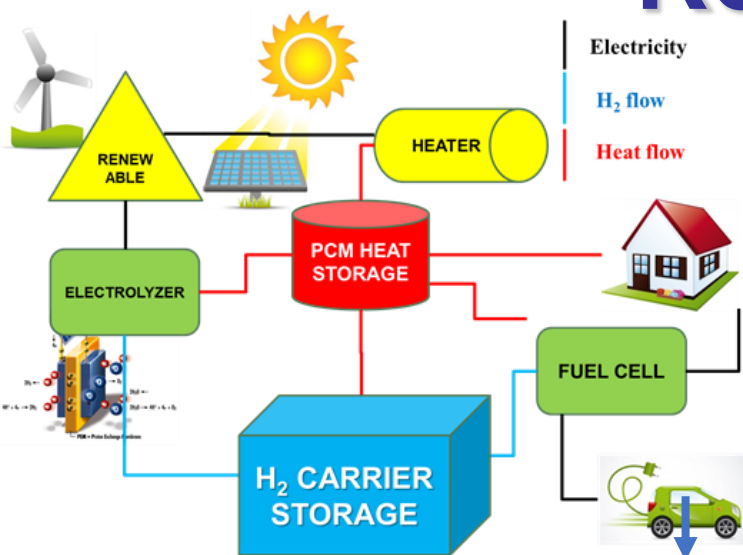
- Two bottles of 1 l or one of 3 l of H₂
- **Type IV bottle**
- H₂ pressure = **300 bar**
- **2 Fuel Cell** : 650 W each
- **Battery**
- Consumption : 8 NI/h
- Power peak: 1000 W
- Total power : 1300 W
- **Time of flight** : 1-1:30 h



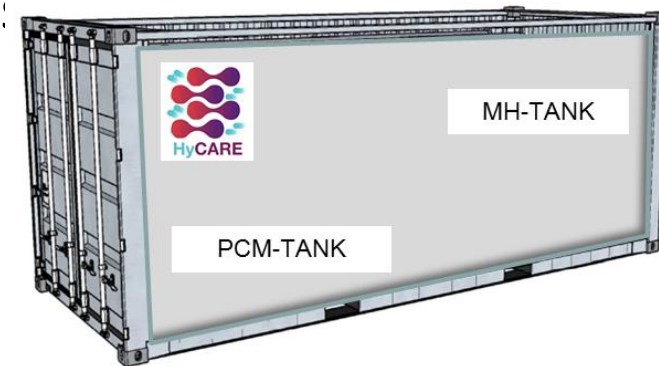


HyCARE

Hydrogen Carrier for Renewable Energy Storage



- Project financed **2019 - 2021**
- Renewable **energy storage**
- Demo plant near Paris (ENGIE)
- Coupled system **H₂ storage – heat storage (PCM)**
- ~ **50 kg of H₂** stored (\approx 4 tons of alloy)
- H₂-carrier: **TiFe-alloy** (no use of CRM)
- Innovative **tank design**



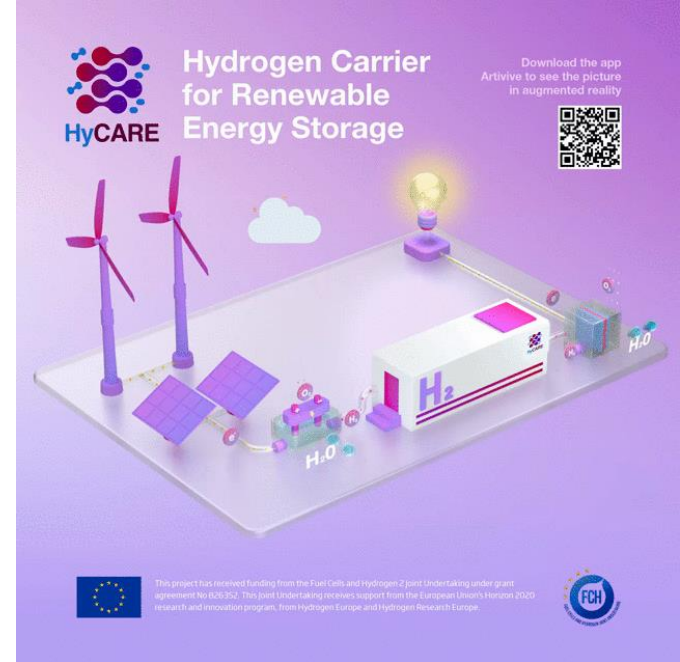
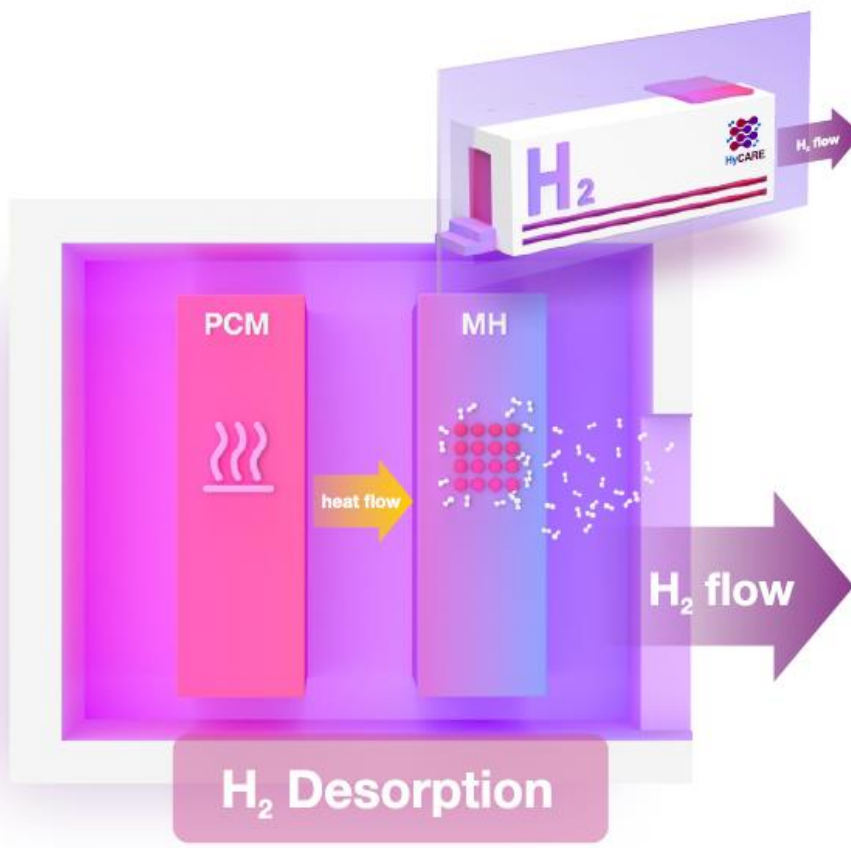
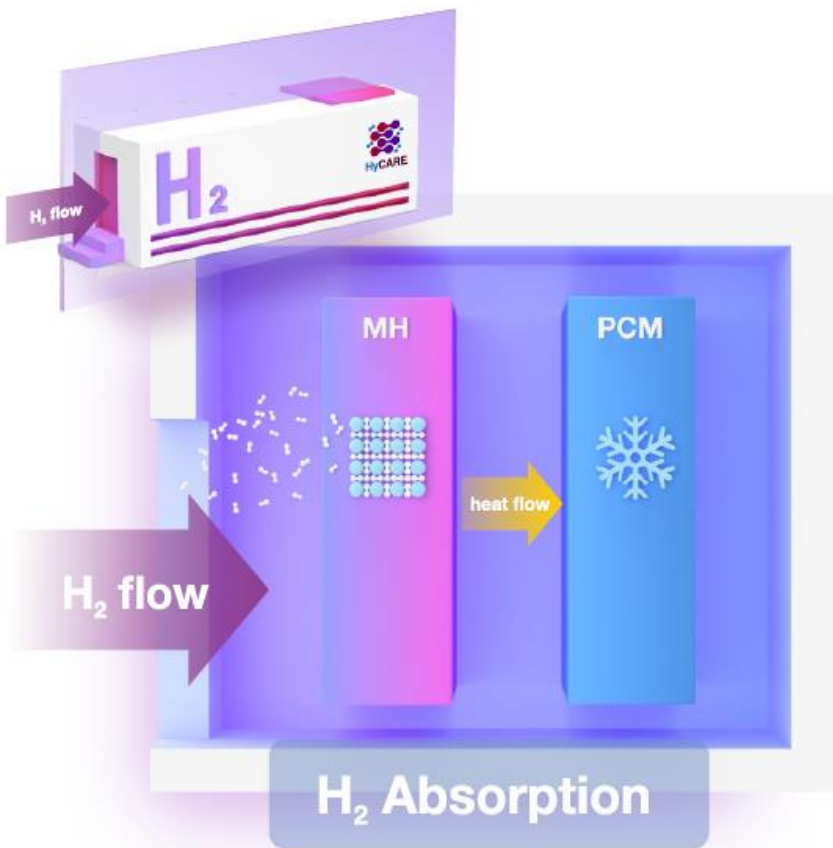
"This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement No 826352. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and Hydrogen Europe Research".



<http://www.hycare-project.eu/>



The concept



"This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement No 826352. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and Hydrogen Europe Research".





H2@UNITO and INSTITUTIONS



**POLITECNICO
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JP Fuel Cells and Hydrogen



Hydrogen valleys



Italian Hydrogen and Fuel Cell Association

