

Applicazioni delle fuel cells e dell'H2

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http://www.lifc.unimore.it/site/home.html

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Seminario telematico ATI sull'idrogeno

Seminario telematico ATI sull'idrogeno (17 settembre 2021)



https://www.atinazionale.it/

Ricerca di competenze per mega progetto H2

<u>https://forms.gle</u>
 <u>/xpPYkuvomBM1</u>
 <u>NZbMA</u>

Ricerca di competenze Ricerca di *Campo obbligatorio
Ditta * La tua risposta
Nome di riferimento * La tua risposta
email * La tua risposta
telefono * La tua risposta



Usi dell'H2 e celle a combustibile



Esempi di applicazione

Trasportabili

Unità che sono incorporate o o servono per ricaricare prodotti che sono progettati per essere spostati Unità di alimentazione ausiliaria (auxiliary power units - APU)



Sistema di illuminazione



http://www.garrygolden.com/wp-content/uploads/2014/04/b-300x161.png



UNIMORE 12/11/2019 https://youtu.be/hv aygJruz4

Esempi di applicazioni



JAVIER ZARRACINA LOS Angeles Times

Esempi di applicazioni







https://www.ballard.com/markets/transit-bus https://youtu.be/ V9B9xurWRY https://youtu.be/7s7TAG6-n7w https://youtu.be/tqi60XX9vP8



H2 storage

Carbon fiber-reinforced 350 and 700 bar compressed hydrogen gas tanks are under development.

The inner liner of the tank is a high-molecular-weight polymer that serves as a hydrogen gas permeation barrier.

A carbon fiber-epoxy resin composite shell is placed over the liner and constitutes the gas pressure load-bearing component of the tank.

An outer shell is placed on the tank for impact and damage resistance.

A pressure regulator for the 700 bar tank is located in the interior of the tank.

There is also an in-tank gas temperature sensor to monitor the tank temperature during the gas-filling process when tank heating occurs





http://www.qtww.com/product/hydrogen/



High- pressure tanks

Hydrogen Safety System



Hydrogen tanks system in ix35 Hyundai

https://www.h2tools.org/sites/default/files/ix35%20FCEV%20ERG_Eng.pdf

- In-Tank Solenoid valve (ITS) supplies
 H₂ at a normal operating condition.
- Pressure Relief Device (PRD) detects temperature of the H₂ tank
- Excessive Flow Valve (EFV) detects an excessive H₂ flow
- Pressure Relief Valve (PRV) vents H₂ to the surrounding atmosphere in case of regulator failure.

The Fuel cell stack

- They use Polymer Electrolyte Fuel Cells, or PEMFC
- Maximum output of about 100-115 kW
- Operating temperatures of approximately 60-80°C



Toyota Mirai FC Stack

http://www.toyota-

global.com/innovation/environmental_technology/technology_file/fuel _cell_hybrid.html



Hyundai ix35 FC Stack http://www.musclecarszone.com/eu-officials-will-drive-hyundai-ix35fuel-cell/

Battery

- To store the energy generated from regenerative braking
- To provide supplemental power during acceleration.
- Nickel-metal hydride or litiumpolymer battery
- Battery are protected

High voltage battery system			
Battery pack voltage	age 180 Volts (Max 206V)		
Battery type	LI-POLYMER		
Number of cells	48 Cells		
Battery system total weight	47 Kg		



https://en.wikipedia.org/wiki/Toyota_Mirai#/media/File:Toyota_Mirai_hydrogen_tank_and_e lectric_battery_SAO_2016_9030.jpg

Esempi di applicazione

Trasporti



https://youtu.be/A8aDmISA9Xg



https://www.wired.com/images_blogs/photos/uncategorized/2007/10/16/fuel_cell_bike.jpg



https://media.treehugger.com/assets/images/2011/10/Blau.jpg

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Bus and trucks

Tabella 5: Principali modelli di veicoli pesanti a celle a combustibile proposti.









Piano Nazionale di Sviluppo Mobilità Italia H2IT Novembre 2019

https://youtu.be/A8dQxhPIQxo





through a fuel cell stack that uses a chemical reaction to convert the hydrogen and ambient oxygen into electricity.

flows through a battery, which powers an electrical motor that spins the wheels and runs the vehicle.*



4. Water vapor is emitted through the tailpipe.

* In some hydrogen fuel cell vehicles, the electricity generated by the fuel cell directly powers the electric motor and does not pass through a battery.

SOURCE USA TODAY research Karl Gelles/USA TODAY

https://eu.usatoday.com/story/money/2020/10/26/hy drogen-trucks-nikola-gm-toyota-hyundai-zeroemissions/5981340002/

Other examples on the market



Alstom's plan is to run the Coradia iLint on non-electrified lines, viewing it as a cheaper and quicker alternative to mass electrification.

https://youtu.be/3MS1yMCg_ts



Alstom FCV train http://www.railwaygazette.com/news/traction-rolling-stock/single-view/view/hydrogen-fuelcell-multiple-units-ordered.html

FCV train

The fuel cell composition and hydrogen fuel tank are placed on the roof of the train, while the lower portion of the train is fitted with the traction motor, traction inverter, AC/DC and DC/DC converter, auxiliary converter and battery composition.



The electricity required for the traction drive and on-board systems is supplied by a fuel cell, which generates energy by combining the stored hydrogen with oxygen in the air.

The kinetic energy recovered during braking and surplus energy generated by the <u>fuel</u> cell is stored in lithium-ion batteries. Excess energy is supplied for normal operations, as well as during acceleration phases of the train.

FCV train

The Coradia iLint is able to reach 140 kilometres per hour (87 mph) and travel 600–800 kilometres (370–500 mi) on a full tank of hydrogen.

The train has seating for 150 passengers and can carry another 150 standing passengers.

According to Rail Engineer and Alstom, a 10MW wind farm is capable of comfortably producing 2.5 tonnes of hydrogen per day; enough to power a fleet of 14 iLint trains over a distance of 600 km per day.

"Hydrail comes of age." railengineer.uk, 5 January 2018.

	Network 1	Network 2
Amount of trains	10	20
Km per day	600 km	750 km
H ₂ per km	0.25 kg/km	
Consumption per day	1.500 kg	3.750 kg

Alstom FCV train

Coradia iLINT Key factors of differentiation

	Diesel hybrid with batteries	Electric train with batteries	Hydrogen fuel cell train
	example	example	Coradia iLINT
Autonomy	■ 900-1000 km	 40-60 km (w/o catenary) -) 	■ > 800 km
Weight	■ High	High	■ Low (< 18 t/axle)
Flexibility in Operation	■ High	Low	■ High
Infrastructure	 Diesel re-fueling 	 Battery charging 	 HRS - Hydrogen Re- fueling Station Usable as well for busses
Environment *) source Bombardier	 Not emission-free 	 Emission-free 	 Emission-free

Figure 5: FCEVs will play an essential role in decarbonizing transport

Projected economic attractiveness



Study: How Hydrogen Empowers the Energy Transition - https://www.h2-view.com/study/

Carrelli elevatori e trattori

https://youtu.be/A0U-UD5_skY



https://youtu.be/62Fd110IcXU



Forklift

- Battery removal
 - Charging room
 - 20 minutes of lost productivity every four to eight hours.
 - H2 fuel cells can be rapidly refueled in as quick as three minutes, allowing operators to get back to work quickly.
 - H2 eliminates the need of significant indoor space for battery charging and storage rooms. This is especially beneficial for operations close to urban centers, where real-estate prices are higher and expanding or investing in a larger facility is extremely expensive.



THE STILL FUEL CELL POWER PACK: A full power plant in minimum space without CO₂ emission



https://www.hiremech.co.uk/blog-hydrogenforklift-trucks/

https://www.yale.com/north-america/en-us/solutions-for-you/adoption-of-hydrogen-fuel-cell-powered-lift-trucks/

Navi



https://www.bbc.com/future/article/20201127-how-hydrogen-fuelcould-decarbonise-shipping

- Hydroville, battello per 16 in servizio tra Kruibeke and Antwerp,
- Dotato di motore ibrido che può funzionare a diesel e H2

Navi

• Catamarano a H2

https://youtu.be/pgdXbe1in64



https://www.independent.co.uk/climate-change/news/energyobserver-hydrogen-powered-zero-emissions-ship-londonclimate-a9146571.html

https://media.techeblog.com/images/toyotaenergy-observer-hydrogen-ship.jpg

Navi



 Sottomarino a celle a combustibile PEM e processo di produzione di H2 da reforming di gasolio



https://media.indiatimes.in/media/photogallery/2013/May/ u36_submarine_1368770558.jpg

https://newatlas.com/fuel-cell-submarines-offer-underwater-stealth/3434/

https://youtu.be/f6E6qyq8fBE

Aereoplani



https://back.3blmedia.com/sites/default/files/styles/ratio_3_2/ public/triplepundit/wide/hydrogen%20plane%20wide.png?h= 6e8c7c8b

https://youtu.be/4iwkTbgU5iA



Un aereo a idrogeno è un aeroplano che utilizza idrogeno come fonte di energia. L'idrogeno può essere bruciato in un motore a getto, o in un altro tipo di motore a combustione interna, o può essere utilizzato per alimentare una cella a combustibile per generare elettricità per alimentare un'elica.

Esempi di applicazione

Stazionario

Unità che forniscono energia elettrica e calore, ma che non sono disegnate per essere spostate.





https://www.enapter.com/



Bloom fuel cells at Apple Maiden, NC data

https://gigaom.com/wp-content/uploads/sites/1/2010/06/chaenergy-server4-1500x1000.jpg



ReliOn fuel cell powering cell site

https://www.altenergymag.com/images/upload/images/ReliOn_Ha german_sm.jpg UNIMORE

Esempi di applicazione

