

Why Hydrogen?

"Hydrogen is today enjoying unprecedented momentum. The world should not miss this unique chance to make hydrogen an important part of our clean and secure energy future ."

Fatih Birol, Executive Director, IEA

Hydrogen can be used much more widely.

There have been false starts for hydrogen in the past;

this time could be different. The recent successes of solar PV, wind, batteries and electric vehicles have shown that policy and technology innovation have the power to build global clean energy industries. California and Europe are proving this.

Solar PV module prices have fallen by around 90% since the end of 2009.



At the end of 2018, module prices in Europe ranged from USD 0.22/W for “low cost” modules to USD 0.42/W for “all black” modules. Benchmark solar PV module prices fell rapidly between 2010 and 2013, but average module prices by country continued falling between 2013 and 2018, with declines between 34% and 61% for gigawatt-scale markets

Hydrogen can enable renewables to provide an even greater contribution. It has the potential to help with variable output from renewables, like solar photovoltaics (PV) and wind, whose availability is not always well matched with demand.

SOURCE: INTERNATIONAL ENERGY AGENCY (IEA)

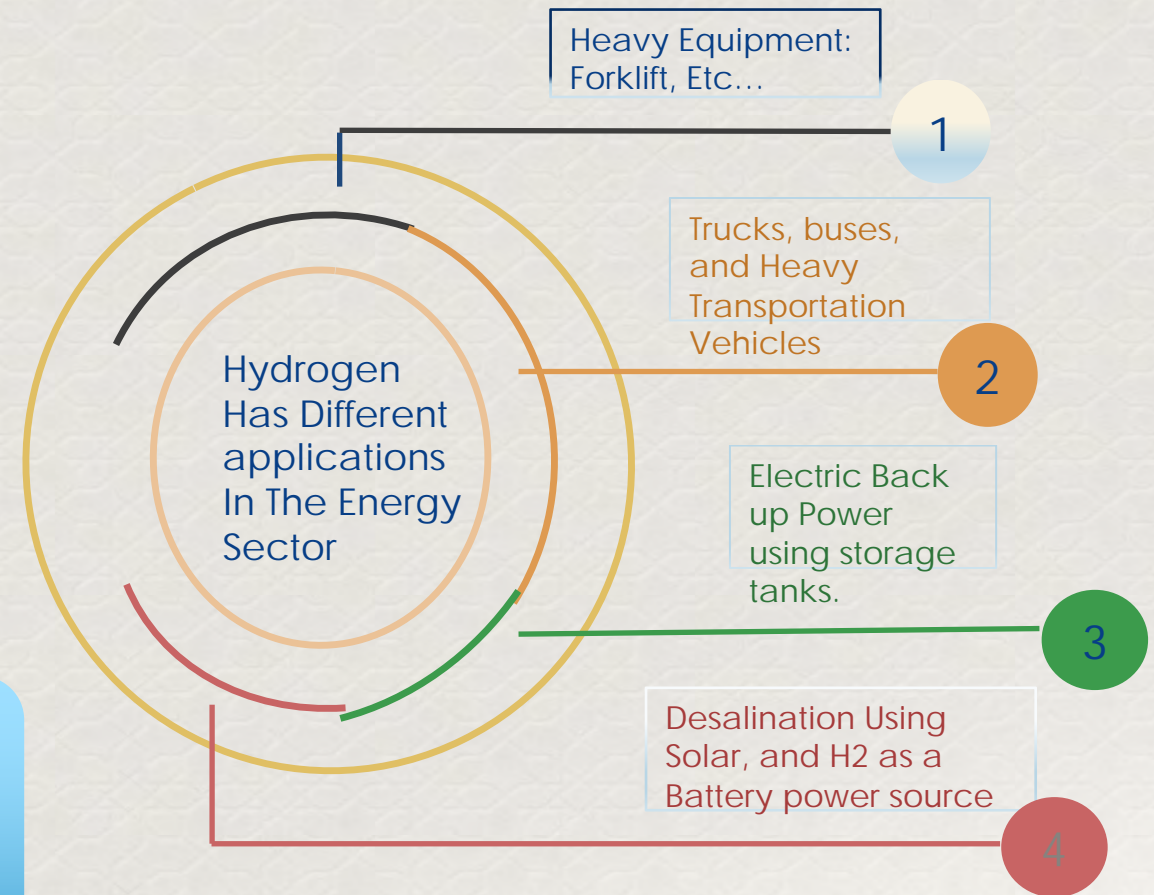
The time is right to tap into hydrogen's potential to play a key role in a clean, secure and affordable energy future.

Hydrogen can help tackle various critical energy challenges.

Hydrogen is versatile.

Technologies already available today enable hydrogen: *to produce, store, move and use energy in different ways.*

Hydrogen is one of the leading options for storing energy from renewables and looks promising to be a lowest-cost option for storing electricity over days, weeks or even months.

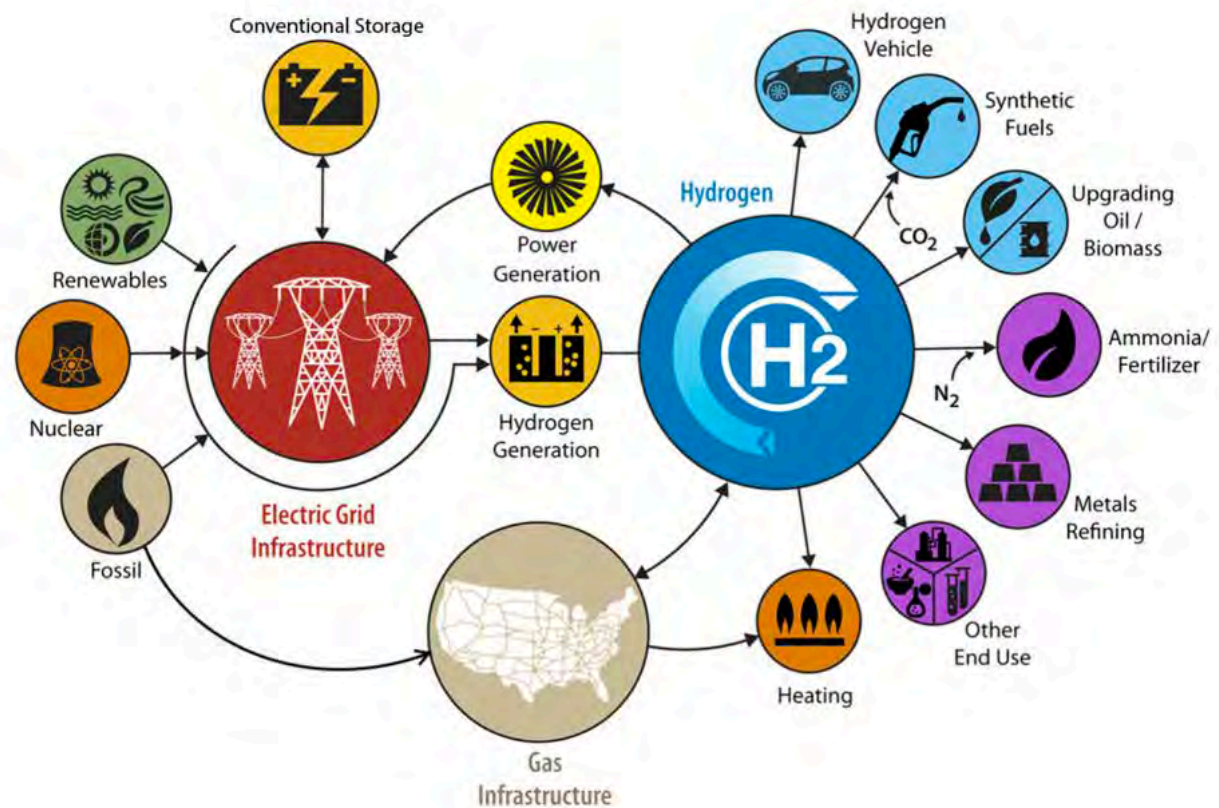


Hydrogen As An Energy Carrier

Hydrogen is not an energy source but an energy carrier, which means that its potential role has similarities with that of electricity.

Different applications of Hydrogen

The crucial difference between hydrogen and electricity is that hydrogen is a chemical energy carrier, composed of molecules and not only electrons.



The International Energy Agency (IEA) and the Future of Hydrogen

1. Hydrogen is already widely used; however, it has not yet realized its potential to support clean energy transitions **due to electricity cost**.
2. Greater attention to the deep **emissions reductions** that hydrogen can help deliver, especially in hard-to-abate sectors is being addressed.
3. Hydrogen is seen as able to contribute to a wider range of policy objectives.
4. Hydrogen can help ensure the **current rapid growth** of renewable electricity continues.
5. Hydrogen can benefit from positive experiences of **developing clean energy technologies**.

Scaling Up Hydrogen

Fuel Cell CARS

Fuel Cell Vehicles are becoming more efficient and compatible with standard fossil fuel vehicles.

There are currently around 11,200 hydrogen-powered cars on the road worldwide. Existing government targets call for that number to increase dramatically to 2.5 million by 2030.

U.S. DEPARTMENT OF
ENERGY

Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY


www.fueleconomy.gov

the official U.S. government source for fuel economy information


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2018 Honda Clarity



2017 Hyundai Tucson Fuel Cell



2018 Toyota Mirai



	Fuel Economy and Related Estimates								
Fuel Economy (mi/kg) ¹	67	68	66	49	48	50	66	66	66
	comb	city	hwy	comb	city	hwy	comb	city	hwy
Range (miles)	366			265			312		
Annual Fuel Cost *	\$1,250			\$1,700			\$1,250		

	Vehicle Characteristics		
Vehicle Class	Midsize Car	Small SUV	Subcompact Car
Motor	AC Permanent Magnet Synchronous (130 kW)	AC Induction (100 kW)	AC Induction (113 kW)
Battery	346 V Lithium Ion	180 V Lithium Ion	245 V NIMH
Availability	Select dealers in California	Select dealers in California (lease only)	Select dealers in California & Hawaii (sale or lease)

* Annual fuel cost calculated assuming a hydrogen cost of \$5.55/kg, 15,000 annual miles of travel, and 55% city and 45% highway driving.

kW = kilowatt; V = volt; kg = kilogram

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Light Duty Fuel Cell Vehicles



RENAULT ENTERS
WITH NEW H₂ FUEL
CELL DELIVERY VAN
IN LATE 2019 AND
EARLY 2020 AND
OFFERS 3 TIMES
MORE RANGE THAT
AN ELECTRIC
VEHICLES.

SOURCE: CaFCP



Fuel Cell Heavy Vehicles

HYUNDAI has a contract to built 1600 NEW FUEL CELL TRUCKS IN SWITZERLAND with H2E.

The new joint venture agreement states that Hyundai will supply a total of 1,600 fuel cell-powered heavy trucks to Hyundai Hydrogen Mobility from 2019 to 2025 – 600 more than originally announced in a memorandum of understanding signed in 2018 between H2E and Hyundai.

NIKOLA DESIGNED A CLASS 8 SEMI TRUCK READY FOR PRODUCTION IN 2021



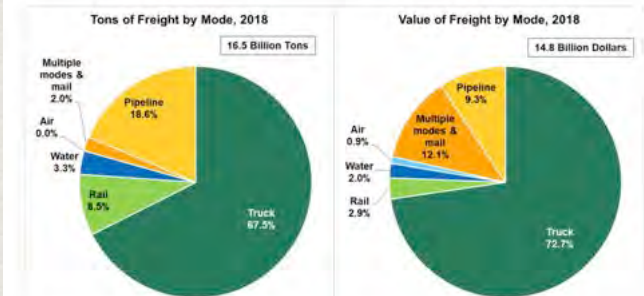
Hyundai Swiss delivered Truck



NIKOLA TRUCK EUROPEAN VERSION

Vehicle Technology Office, DOE,
Document FOTW #1150, September 7,
2020:
In the USA Trucks Moved 68% of All
Freight by Weight and 73% of Freight by
Value in 2018

totalled 16.5 billion tons with a total value of \$14.8 billion.



Opportunities to Scale Up Hydrogen in the heavy transportation Industry
Trucks, Buses, Trains, and Aviation is waiting for lawmakers to implement legislations to
reduce CO₂ Emissions in their States and region!

Fuel Cell Heavy Vehicles, Buses

TRANSPORTATION AGENCIES ARE FOCUSING IN CLEAN MOBILITY AND NOT PURCHASING OR USING DIESEL BUSES BY 2030 IN CALIFORNIA AND OTHER STATES IN THE USA



Xcelsior XHE40 Fuel Cell Bus

