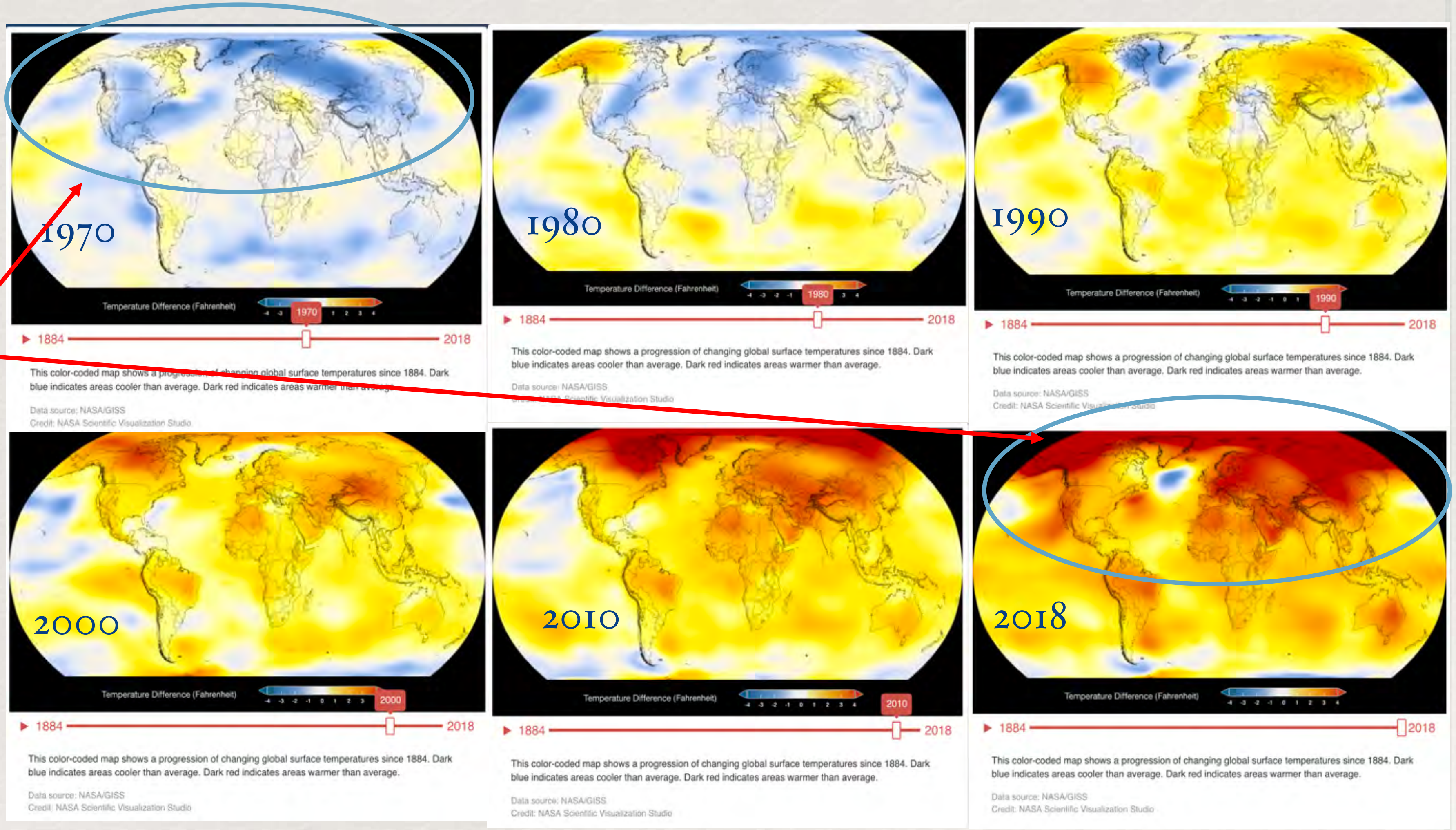
Temperature data from the last 48 years. Source: Nasa Climate Change

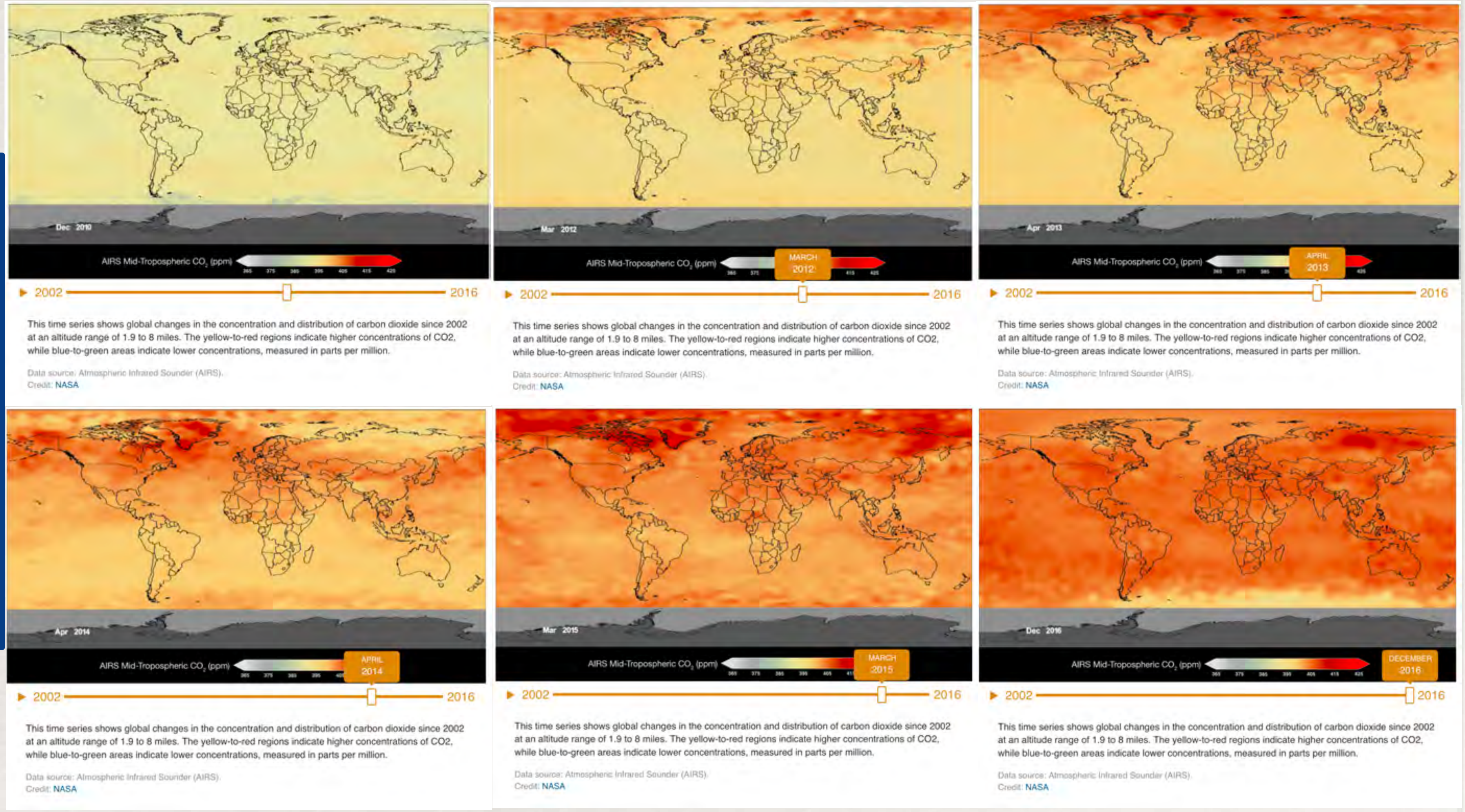
Huge Change in temperature from 1970 to 2018.
The transportation industry is one of the major contributors; however, electricity from coal is a larger factor.



Carbon dioxide since 2002 at an altitude range of 1.9 to 8 miles by NASA.

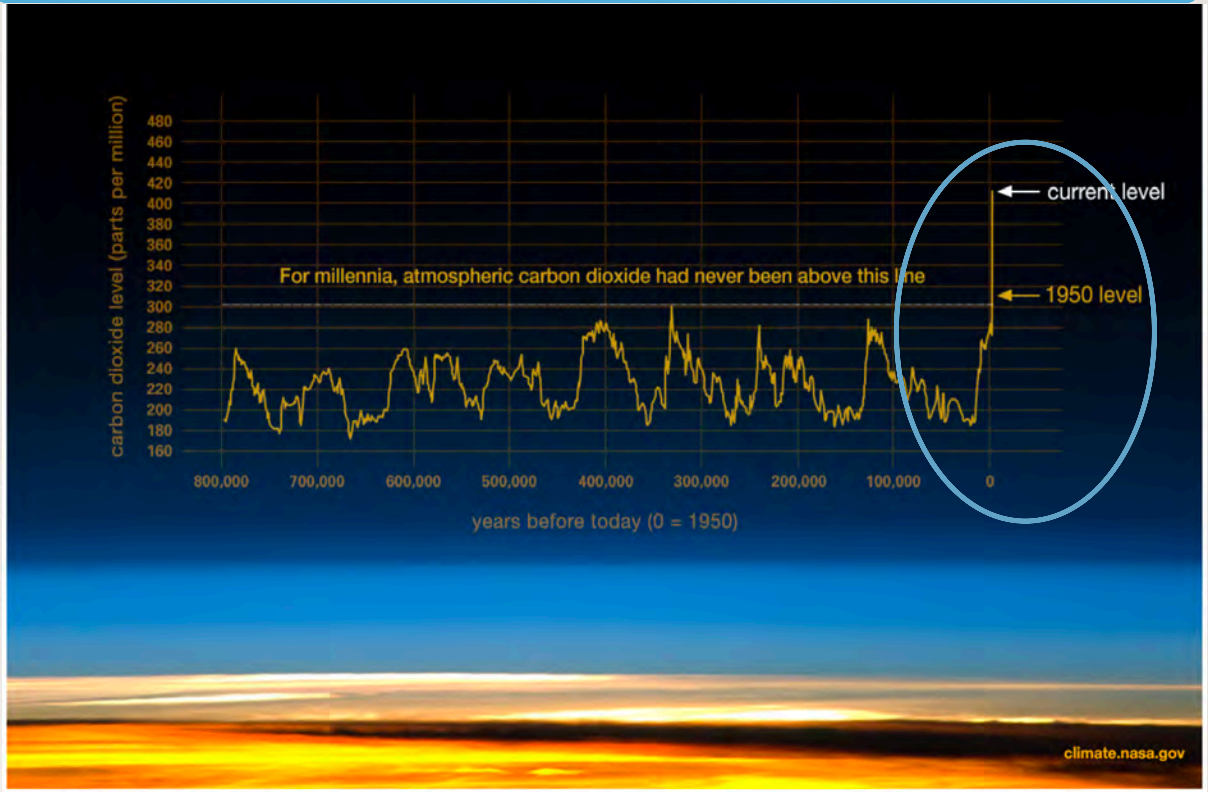
The yellow-to-red regions indicate higher concentrations of CO_2,

In Less than 10 years CO_2 has increased to highest levels. From 2002 to 2016 this data from "NASA Climate Change" shows an alarming increase in CO_2 Emission in the world.
There is not Planet B!



Paris, December 12, 2015: 195 countries signed a legally binding agreement to keep global warming well below 2°C – an ambitious goal that will require the economies around the globe to decarbonize large parts of the world's energy system.

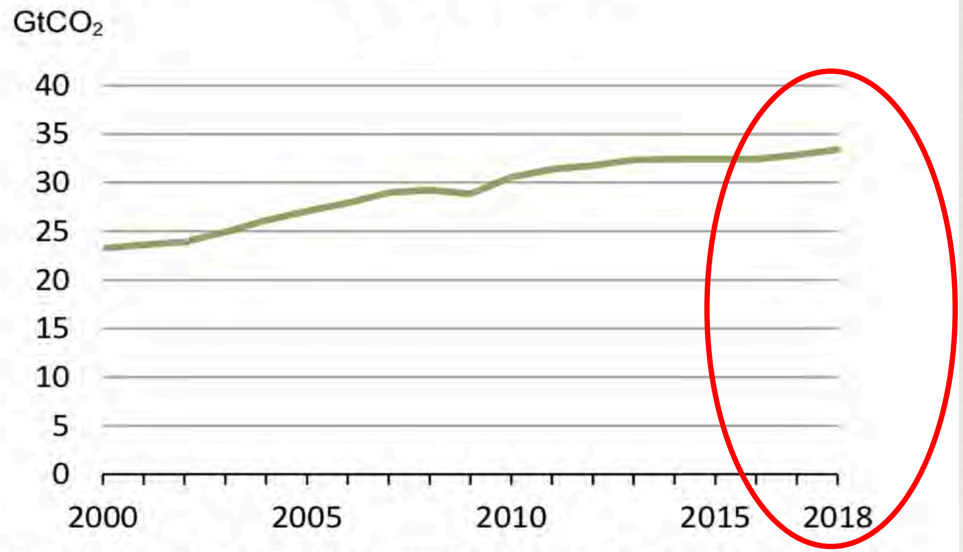
Highest levels of CO2 Emissions. Data taken from Ice Tubes



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.) Find out more about ice cores (external site).

Transportation CO2 emissions 32GTCO2

Figure 1. CO_2 emissions from fuel combustion: global trend



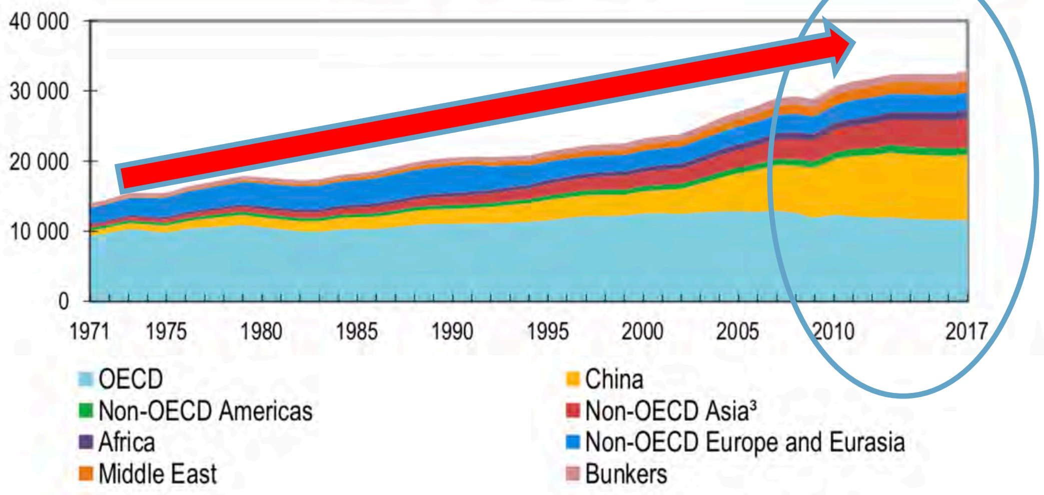
Source: values up to 2017 for World and 2018 for OECD are based on IEA (2019) *CO_2 emissions from fuel combustion*. The 2018 value for World is based on IEA (March 2019) *Global Energy & CO_2 Status Report* (https://www.iea.org/geco/).

Data from IEA (International Energy Agency) of the OECD.

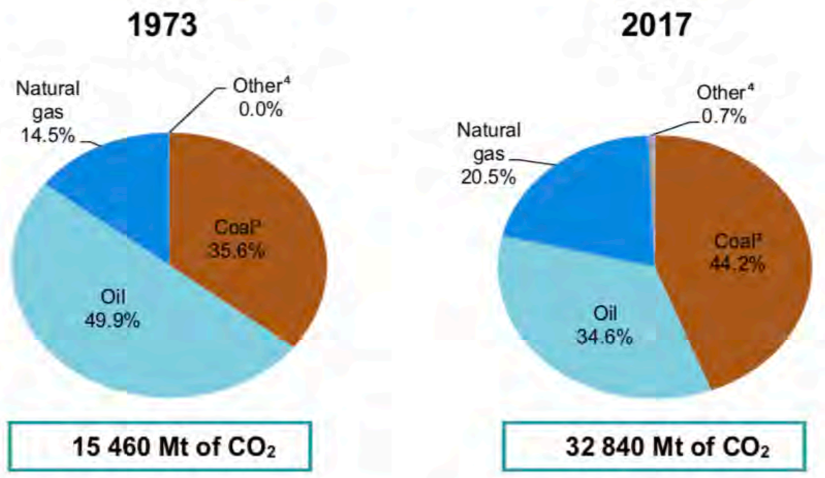
(Organisation for Economic Co-operation and Development Countries, Members and Non-Members)

CO_2 emissions by region

World[1] CO_2 emissions from fuel combustion[2] from 1971 to 2017 by region (Mt of CO_2)



1973 and 2017 fuel shares of CO_2 emissions from fuel combustion[2]



1. World includes international aviation and international marine bunkers.
2. CO_2 emissions from fuel combustion are based on the IEA World Energy Balances and on the 2006 IPCC Guidelines, and exclude emissions from non-energy.
3. In these graphs, peat and oil shale are aggregated with coal.
4. Includes industrial waste and non-renewable municipal waste.

Source: IEA, CO_2 Emissions from Fuel Combustion, 2019.

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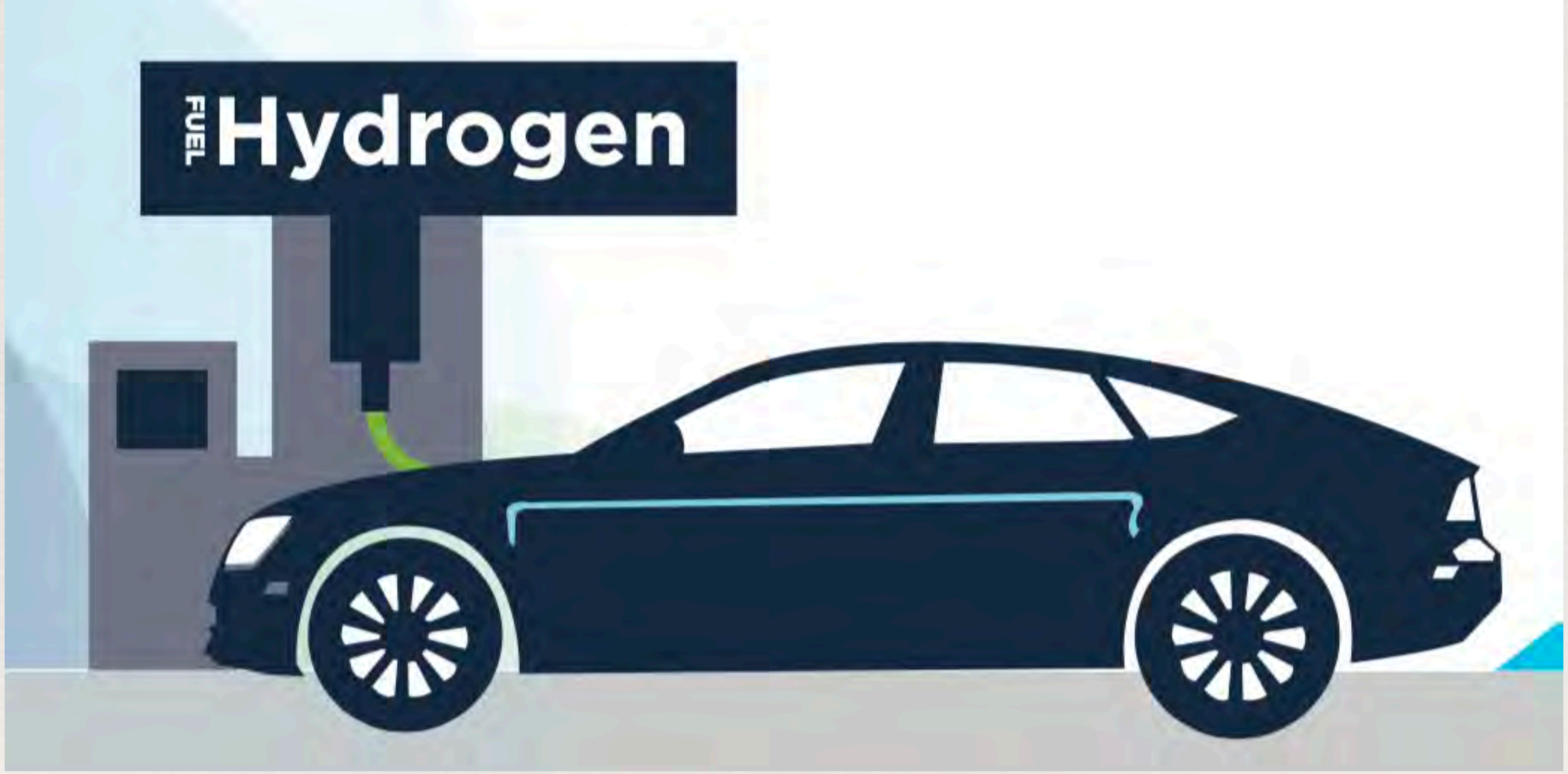
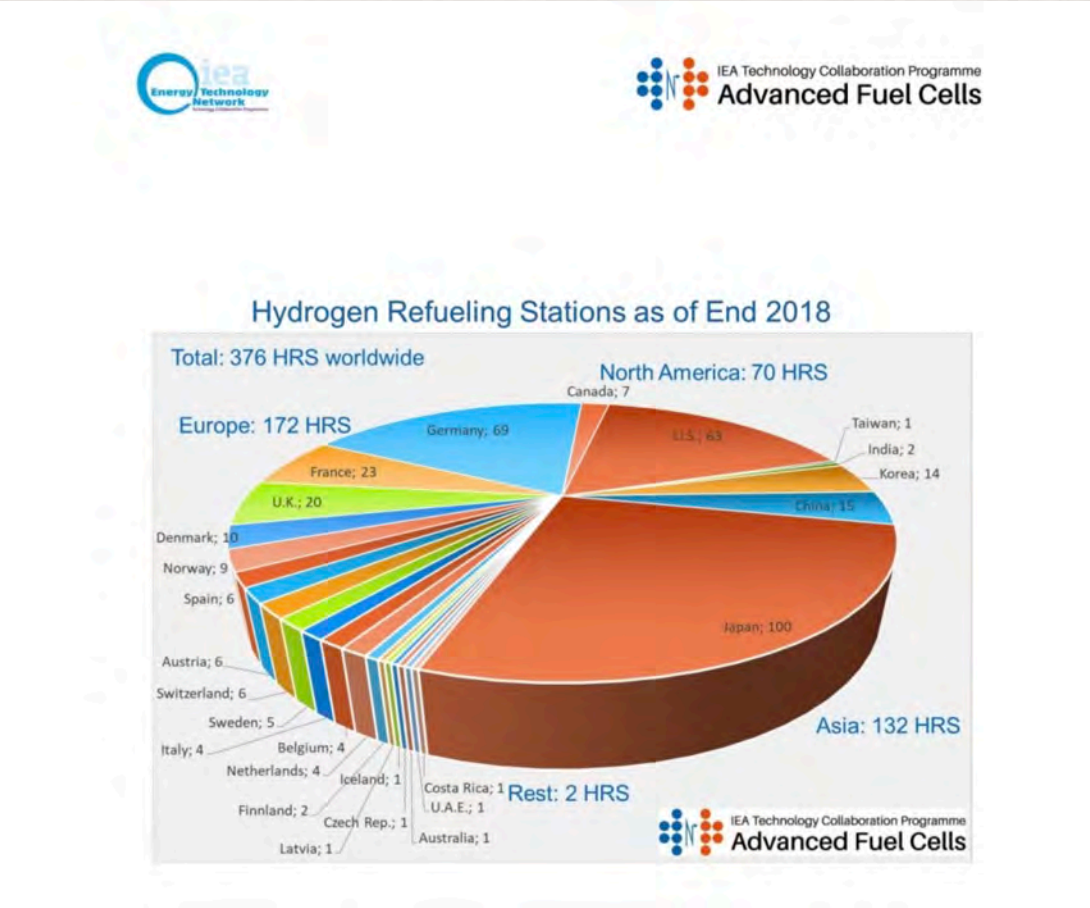
WHAT ARE THE CHALLENGES AND OPPORTUNITIES?



HYDROGEN INFRASTRUCTURE



VERY ALARMING THE H_2 DEVELOPMENT IN SOUTH AMERICA USING RENEWABLE ELECTRICITY TO PRODUCE HYDROGEN

Worldwide HRS (Hydrogen Refueling Stations): **376 and increasing!**

Asia HRS: **132**

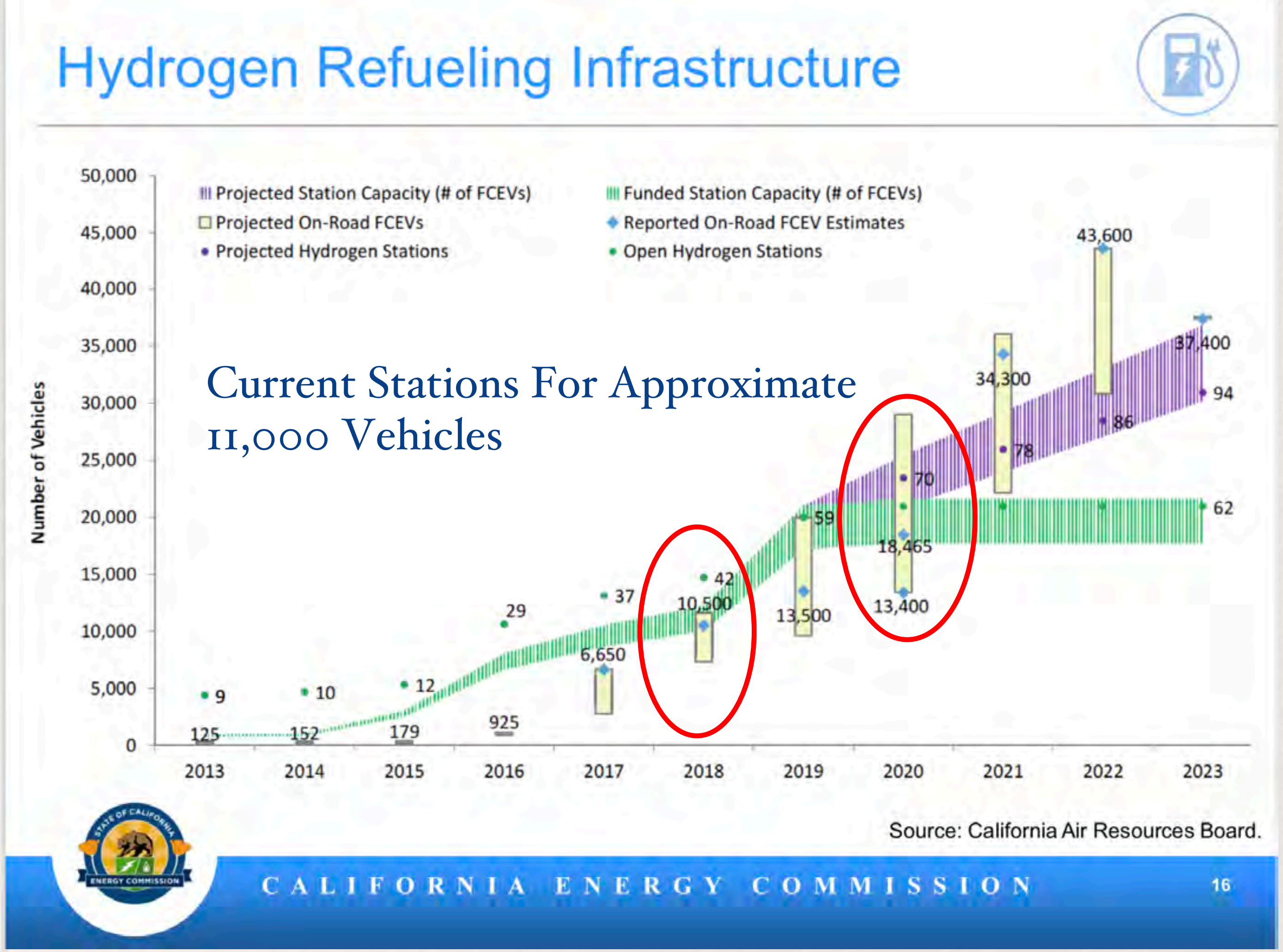
Europe HRS: **172**

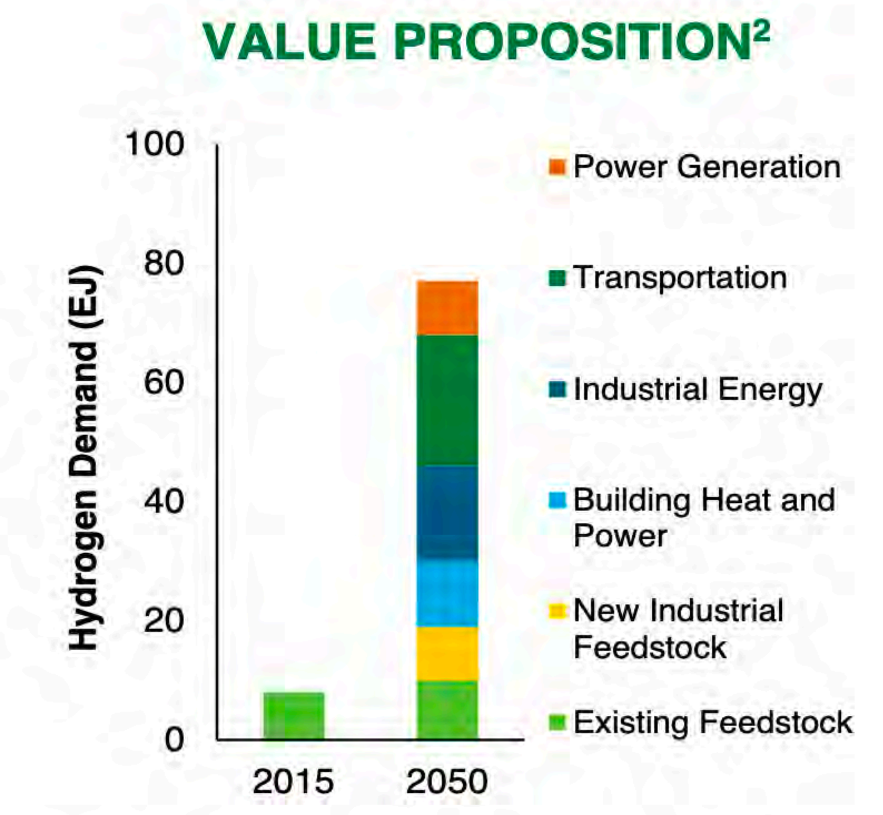
North America HRS: 70

South/Latin America HRS Using Electricity from Solar and Wind: **1** (Costa Rica).

INFRASTRUCTURE MUST BE FIRST AND VEHICLES OEM WILL FOLLOW.

Hydrogen Demand EJ (ExaJoules)





2. Source: "Hydrogen Scaling Up." Hydrogen Council. November 2017. http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf

California Estimated job creation from Hydrogen introduction

Challenge: Infrastructure Initial Investment

Opportunities: Hydrogen Create jobs as the technology is evolving

Figure 16. Job Creation Estimation from California Hydrogen Station Investment

	(100 Stations)	(200 Stations)
CA H2 Station Investment	$200,000,000	$400,000,000
Job Years ($92,000)	2,174	4,348
Direct and Indirect Jobs (64% of a job year)	1,391	2,782
Induced Jobs (36% of a job year)	783	1,566
Total Jobs from Station Investment	2,174	4,348

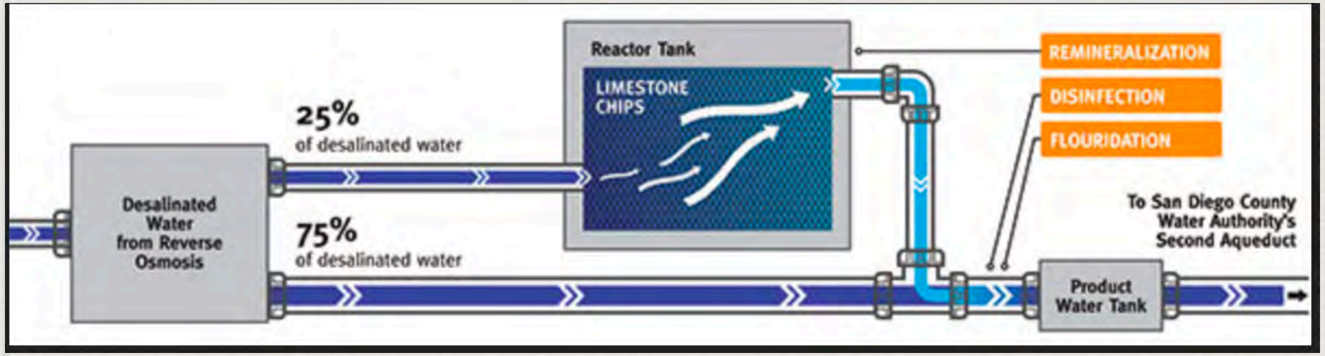
Source: *Calculated by EIN Using ARRA Methodology*

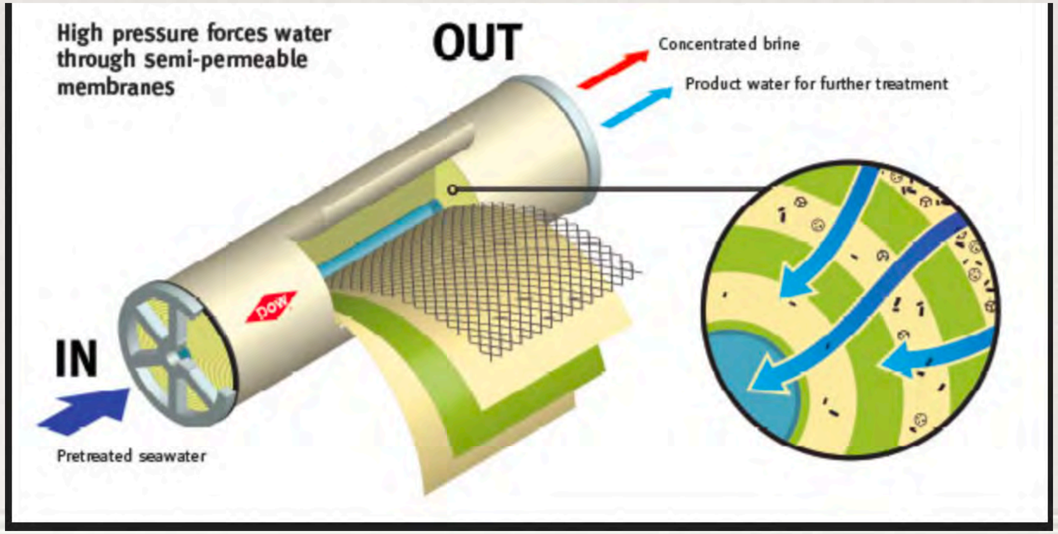
Source: CaFCP (California Fuel Cell Partnership)

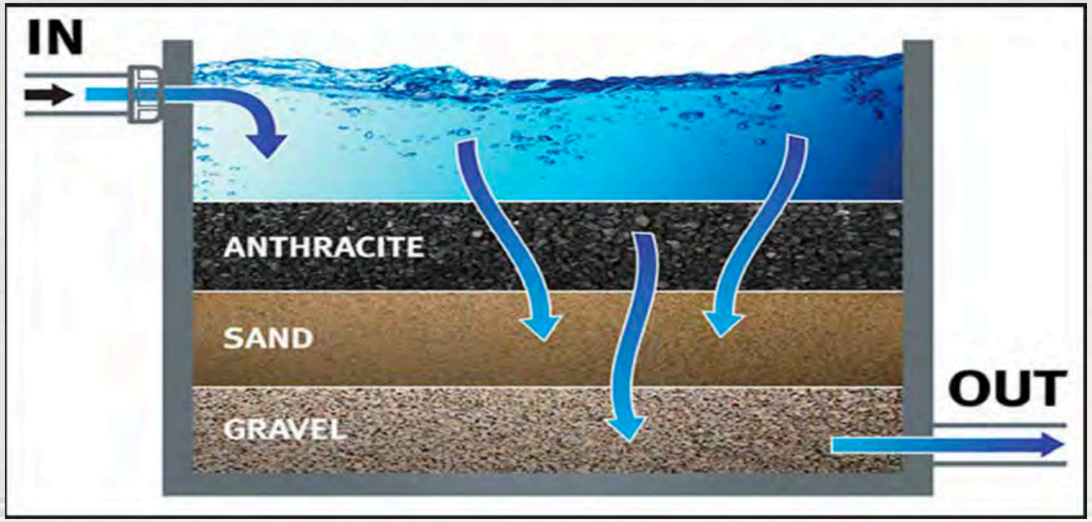
Use desalination plants to use water to produce hydrogen.

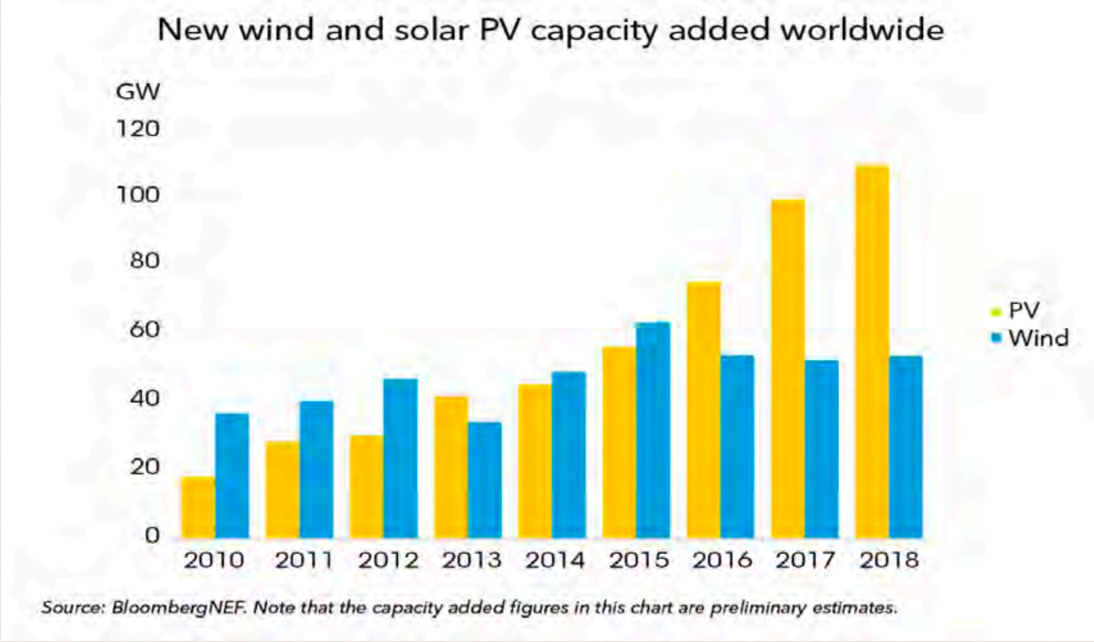
Use Renewable Electricity to run the desalination plant.

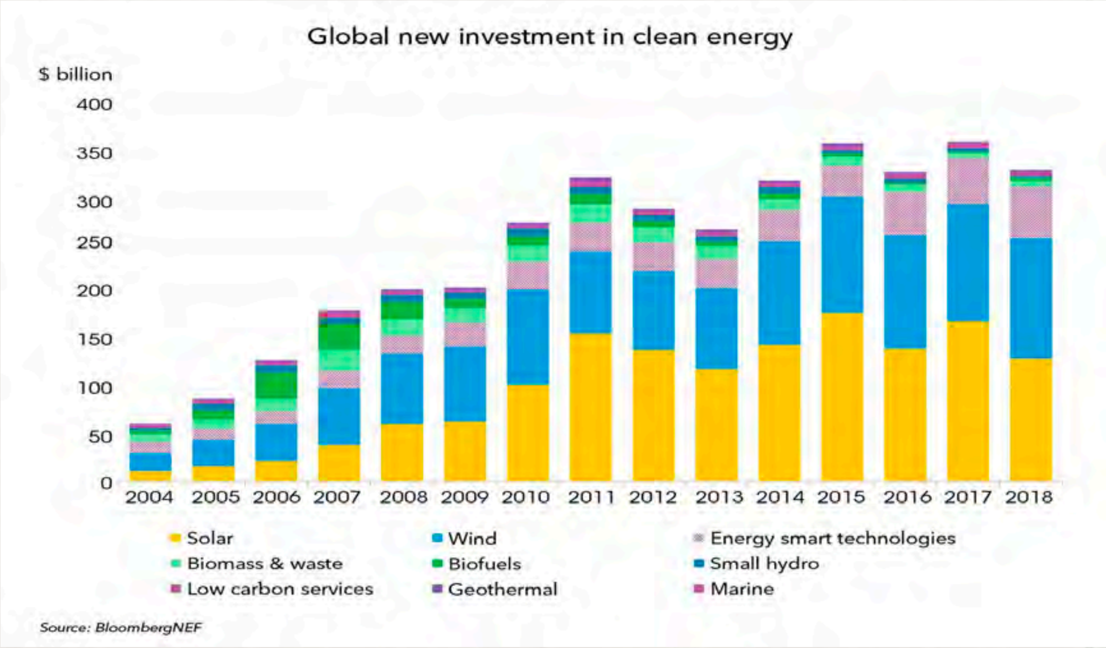
Carslbad Desalination Plant, California








New wind and solar PV capacity added worldwide
GW
120
100
80
60
40
20
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
PV
Wind
Source: BloombergNEF. Note that the capacity added figures in this chart are preliminary estimates.

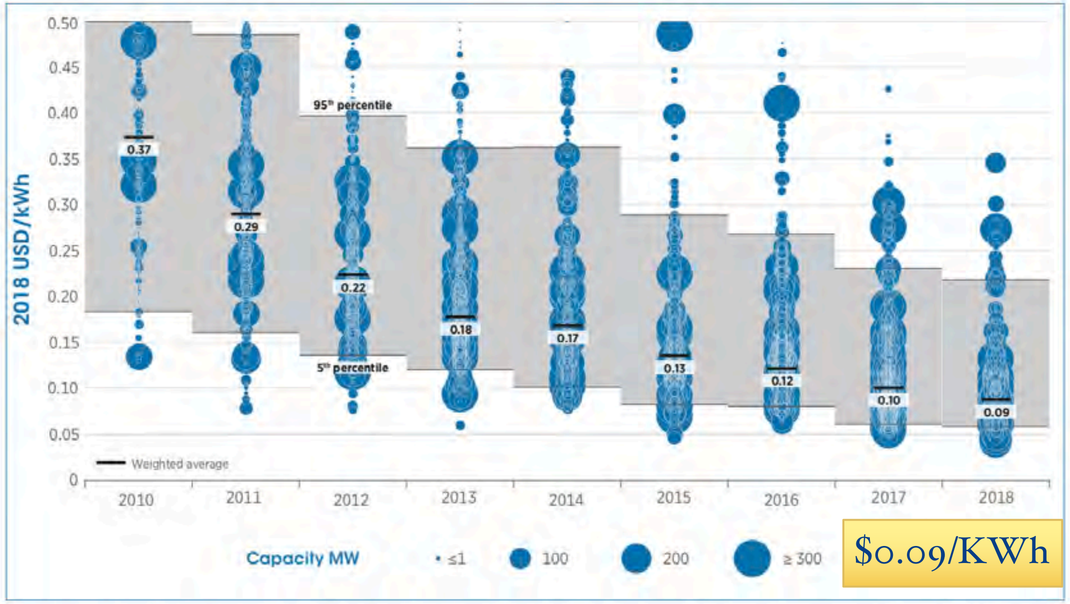

Global new investment in clean energy
$ billion
400
350
300
250
200
150
100
50
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Solar
Wind
Energy smart technologies
Biomass & waste
Biofuels
Small hydro
Low carbon services
Geothermal
Marine
Source: BloombergNEF

Cost of Electricity.

Challenge. The fluctuating Long-term cost of Electricity makes it challenging to model the lifetime cost of operating the electrolizer.

Opportunity. The lower cost of Wind and Solar electricity will help reduce the operating cost of the Electrolizer; as a result, lowering the cost of KG/H2 to the goal of $2.00 Kg/H2 from the current of approximate $12.00Kg/H2.

Figure 2.6 LCOE from utility-scale solar PV projects, global weighted average and range, 2010-2018

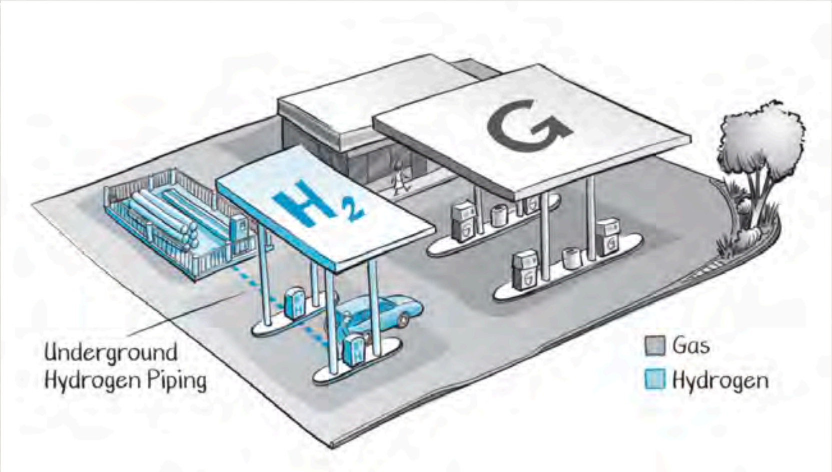


The global weighted-average LCOE of utility-scale solar PV declined by 77% between 2010 and 2018, from USD 0.371 to USD 0.085/kWh. Globally, although the range has narrowed, the 5th and 95th percentile for projects in 2018 ranged from USD 0.058 to USD 0.219/kWh.

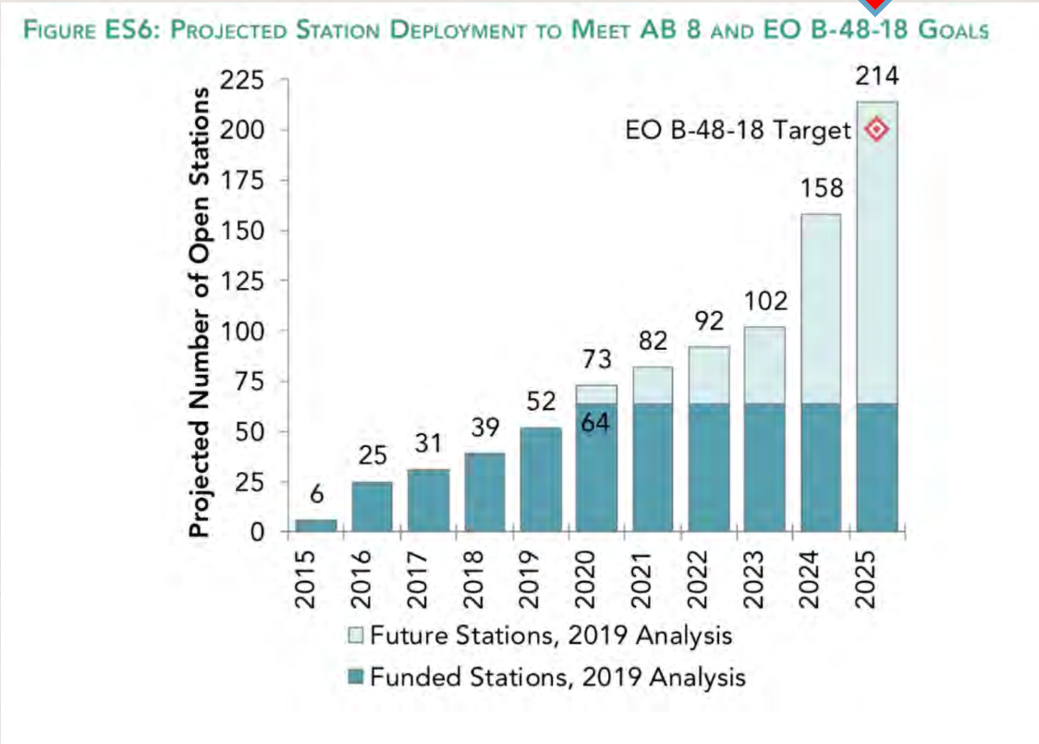
Figure S.6 Global weighted average total installed costs, capacity factors and LCOE for offshore wind, 2010–2018

Source: IRENA Renewable Generation Power Cost 2018 report

FOCUS on infrastructure first



California goal is to have 214 working Stations by 2025



—CaFCP Goal—

Enable market conditions to support:

1,000 hydrogen stations

and

1,000,000 fuel cell vehicles

by **2030**

One Challenge is to have enough volume to reduce the Kg/H2 cost being dispense using different technologies

Delivered hydrogen prices are highly sensitive to hydrogen refuelling station utilisation.

For example, a ratio close to 10 cars per station (as is the case in Europe) implies that pumps operate less than 10% of the time. If the refuelling stations were as small as 50 kgH2 per day this translates to a high price of around USD 15–25/kgH2 if the costs of building and operating refuelling stations are repaid by fuel sales over the lifetime of a station.

Source: IEA The Future Of Hydrogen

The Leonardo Di Caprio Foundation

Target Price of Kilogram of Hydrogen is $2.00 or less Using Renewable Electricity

Figure 11. Costs of Production for Renewable Hydrogen Pathways (Does Not Include CSD)

Pathway	Renewable Level	Technology	Input	Plant Capacity	Levelized Cost of Production ($/kg)
Solar PV + CA Grid to H2 - 1MW	32%	PEM Electrolysis	Grid and Solar Electricity, Water	398kg/day	$8.02
100% Solar PV Generation to H2 - 1MW	100%	PEM Electrolysis	Grid Electricity, Water	126kg/day	$15.43
Biogas to H2	100%	SMR	Landfill, Wastewater or Dairy Biogas	1500kg/day	$2.94
Tri-Generation Biogas to H2	100%	Tri-Generation	Biogas	1500kg/day	$5.99
Natural Gas to Hydrogen	0	SMR	Natural Gas	398kg/day	$2.17

Source: *Levelized Cost of Production Calculated by EIN using data from "California Power-to-Gas and Power-to-Hydrogen Near-Term Business Case Evaluation" Eichman, Josh, Flores-Espino, Francisco, National Renewable Energy Laboratory, December 2016*

EIN energy independence now

Therefore, Heavy-Duty Vehicles should be Consider first in order to have large Volume And bring the K/H_2 cost down.

NIKOLA II and NIKOLA III Versions

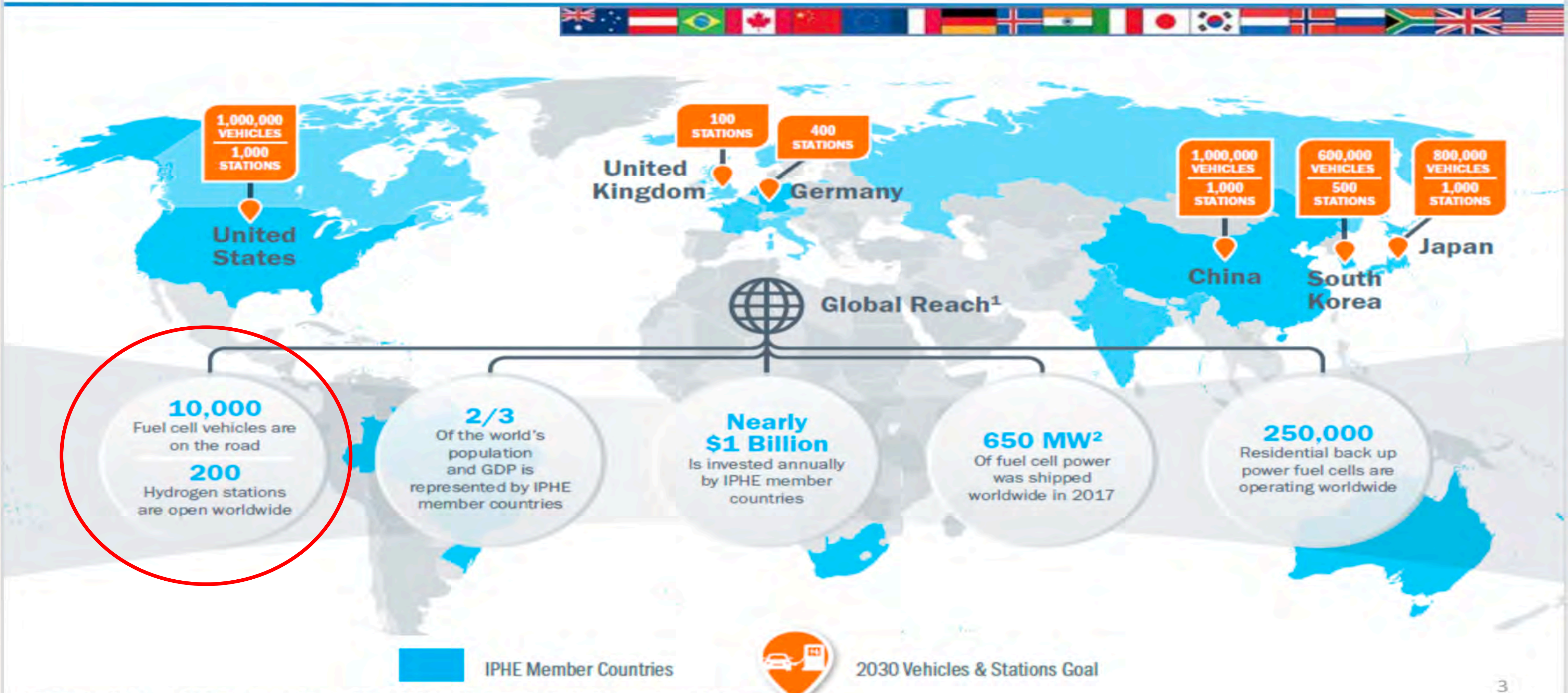
Cummins Hydrogen Fuel Truck

Cummins showcases hydrogen fuel cell truck

HDC-6 NEPTUNE CONCEPT

Hyundai's HDC-6 Neptune Concept Class 8 heavy-duty truck. (All photos: Hyundai)

Global Activities and Commitments are Strong – see IPHE Fact Sheet



[1] IPHE Country Updates [2] U.S. Department of Energy, E4tech. 2018 [3] *Hydrogen Scaling Up*. Hydrogen Council, 2017

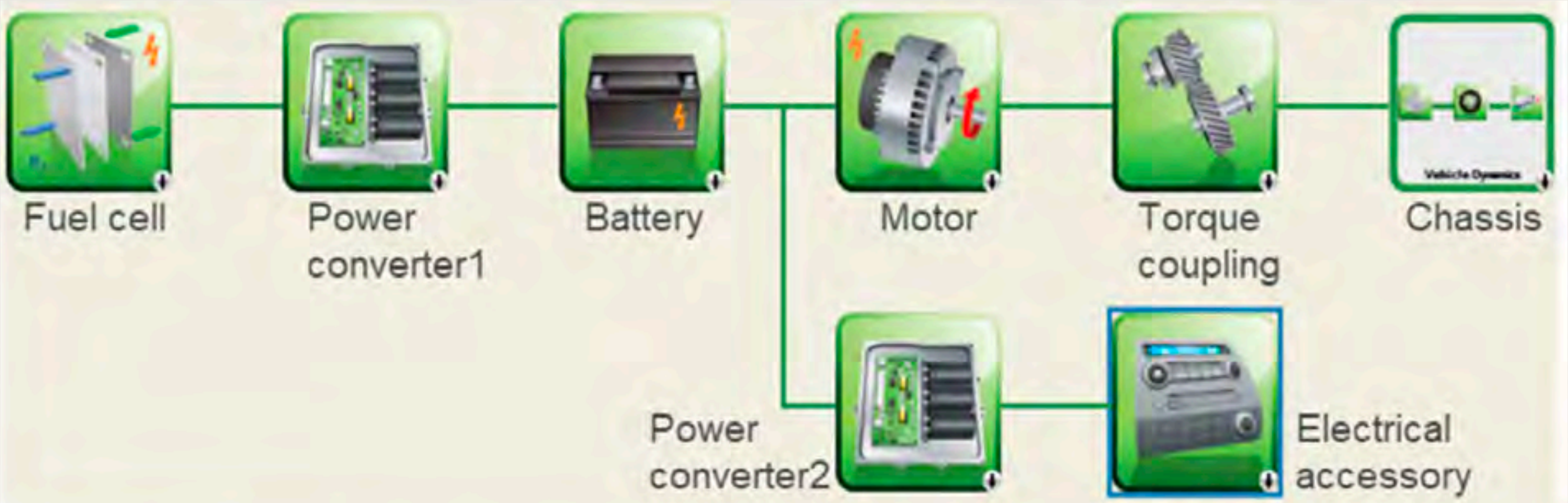
“Hydrogen may start to become a serious factor in our driving lives sooner than we think,”

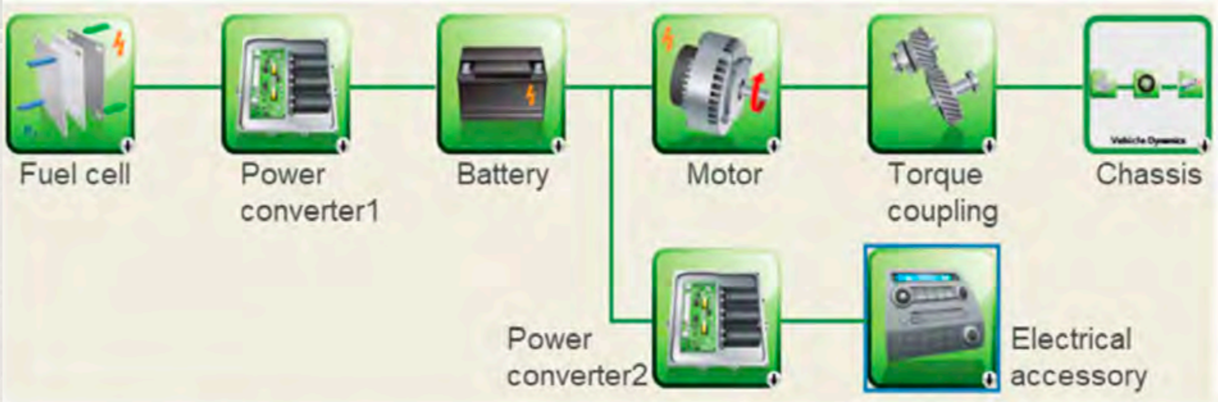
SOURCE: Hydrogen Council; IEA ETP Hydrogen and Fuel Cells CBS; National Energy Outlook 2016

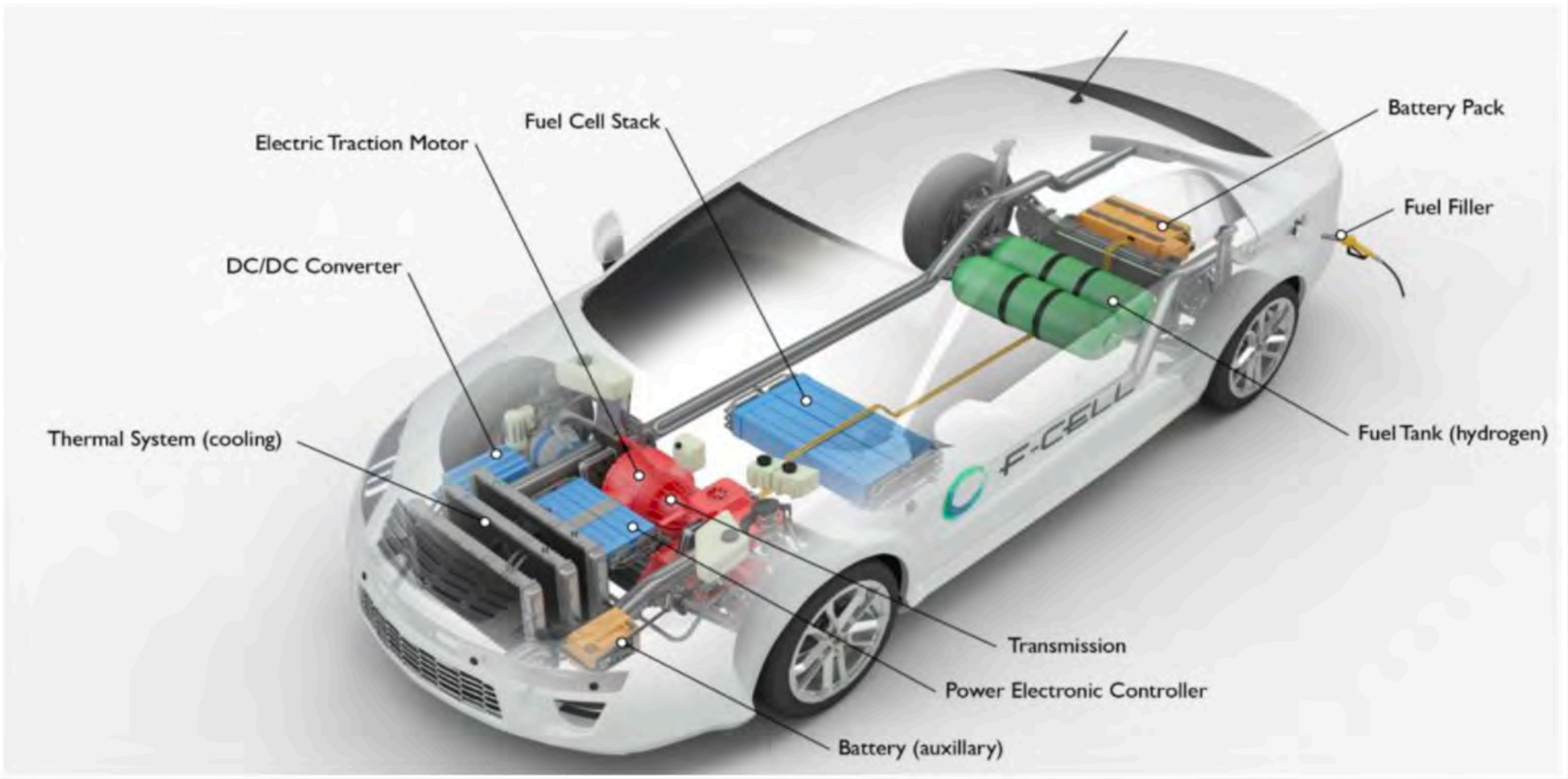
secretariat@hydrogencouncil.com
www.hydrogencouncil.com

So, How Does Fuel Cell and Electrolizer works?

Configuration of fuel cell electric vehicle (FCEV) in Autonomie.




Fuel cell
Power converter1
Battery
Motor
Torque coupling
Chassis
Power converter2
Electrical accessory

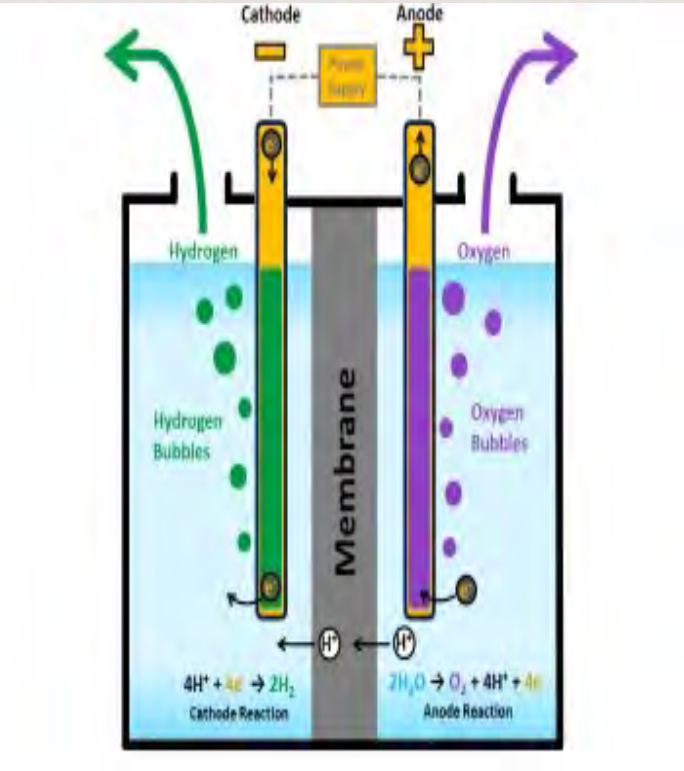

Electric Traction Motor
Fuel Cell Stack
Battery Pack
Fuel Filler
DC/DC Converter
Thermal System (cooling)
Fuel Tank (hydrogen)
Transmission
Power Electronic Controller
Battery (auxillary)

Hydrogen Production By Electrolysis

Like fuel cells, electrolyzers consist of an anode and a cathode separated by an electrolyte.

This reaction takes place in a unit called an electrolyzer.

Electrolysis is the process of using electricity to split water into hydrogen and oxygen.

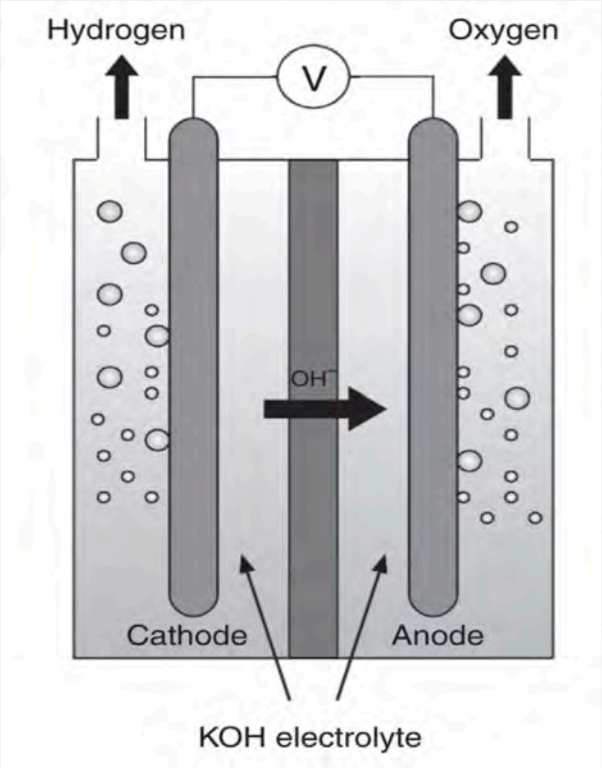


There are three types of Electrolyzers in use with different technologies.

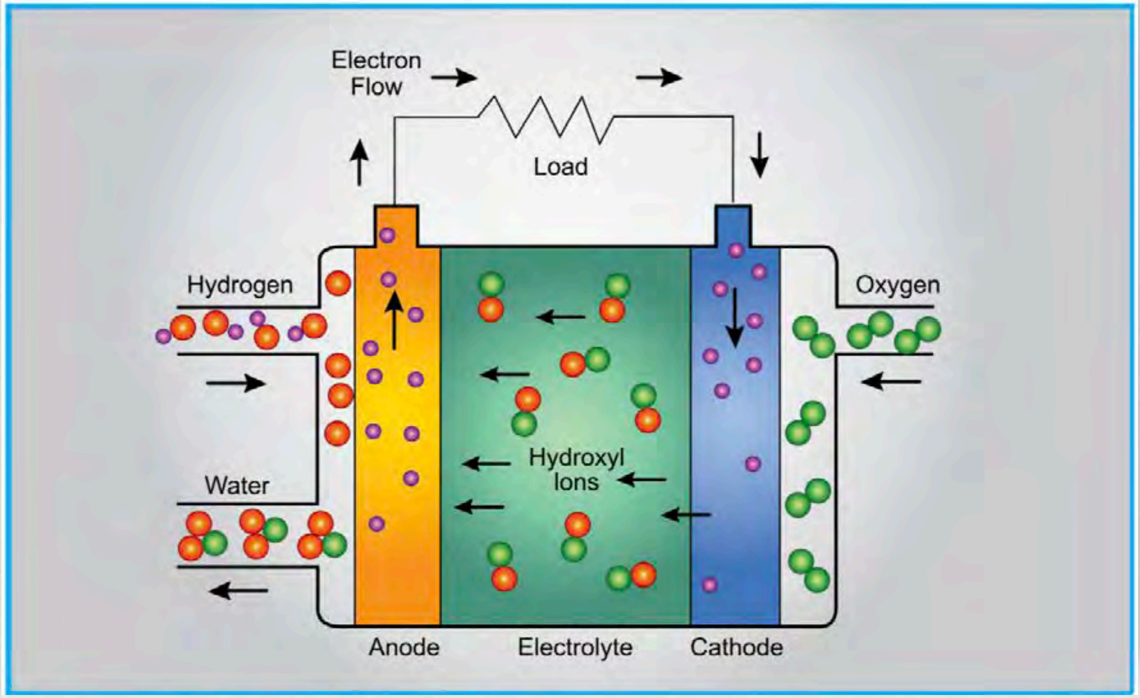
Alkaline Electrolyzers

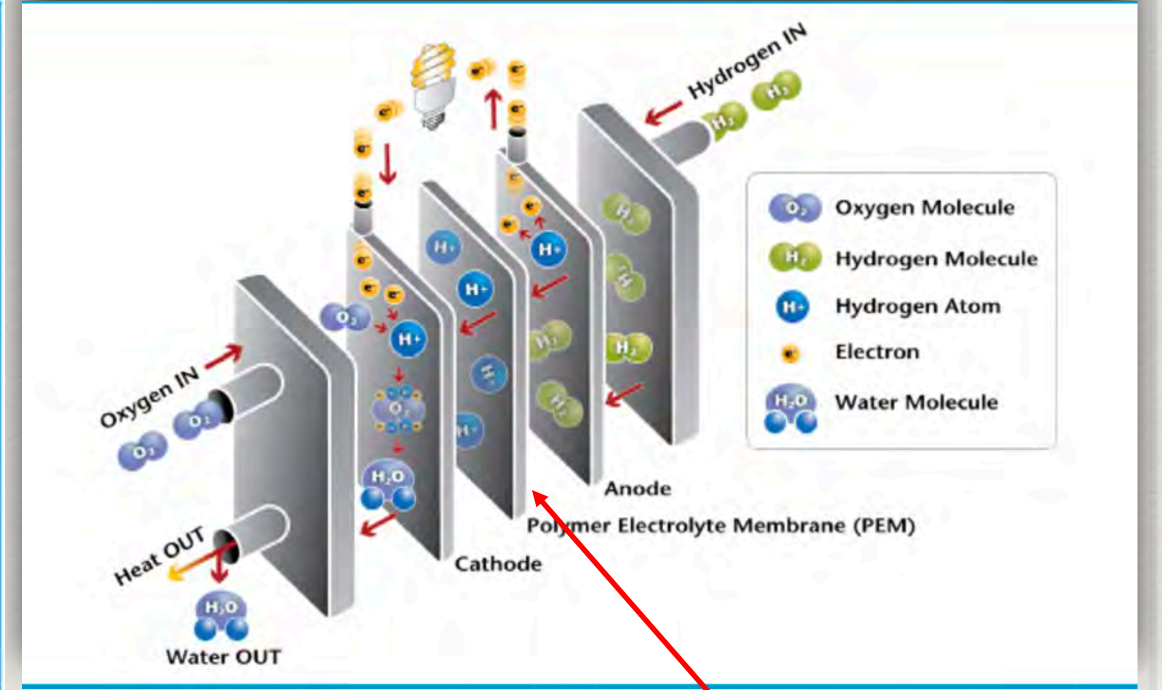
Solid Oxide Electrolyzers

Polymer Electrolyte Membrane Electrolyzers



The technology behind the Fuel Cell





The cost of electricity is the mayor factor influencing the cost of hydrogen. However, Renewable electricity, Solar, and Wind are becoming more affordable, reducing the cost of Hydrogen production . The goal of the industry is to bring it down to $2.00 per kilogram of Hydrogen.

Platinum is one of the elements currently used in the Fuel Cells, which increases the cost of the electrolizer. However, research is being done to use other materials to reduce the cost, like Ceramics.