



Το Υδρογόνο ως εναλλακτικό καύσιμο

ecoMOBILITY CONFERENCE 2018
22 Μαρτίου, Αίγλη Ζαπείου

Αθ. Στούμπος
Εργ. Περιβαλλοντικών Ερευνών, ΙΠΡΕΤΕΑ, ΕΚΕΦΕ ΔΗΜΟΚΡΙΤΟΣ





TOP 10 EMERGING TECHNOLOGIES OF 2017

*a collaboration between Scientific American and
the World Economic Forum*



1. Water Made by the Sun - Technologies that pull moisture from the air are now solar-powered
2. Fuel from an Artificial Leaf - Technology that mimics photosynthesis converts carbon dioxide to fuels in a sustainable way
3. AI that sees like humans - A deep-learning tool for visual tasks is changing medicine, security and more
4. Precision Farming - Sensors, imaging and real-time data analytics improve farm outputs and reduce waste
5. Mapping Every Cell - A global project aims to understand how all human cell types function
6. Liquid Biopsies – Ultrasensitive blood tests promise to improve cancer diagnosis and care
7. Hydrogen Cars for the Masses - Reducing precious metals makes fuel-cell catalysts affordable
8. Genomic Vaccines - Vaccines composed of DNA or RNA could enable rapid development of preventives for infectious diseases
9. Sustainable Communities – Instead of “Greening” individual houses, entire blocks of homes are retrofit into a single efficient unit
10. Quantum Computing - New algorithms and Techniques open the door to innovative applications

Alternative Fuels Directive

Electricity – Hydrogen - Biofuels



9635

ΕΦΗΜΕΡΙΔΑ ΤΗΣ ΚΥΒΕΡΝΗΣΕΩΣ ΤΗΣ ΕΛΛΗΝΙΚΗΣ ΔΗΜΟΚΡΑΤΙΑΣ

30 Νοεμβρίου 2016

ΤΕΥΧΟΣ ΠΡΩΤΟ

Αρ. Φύλλου 222

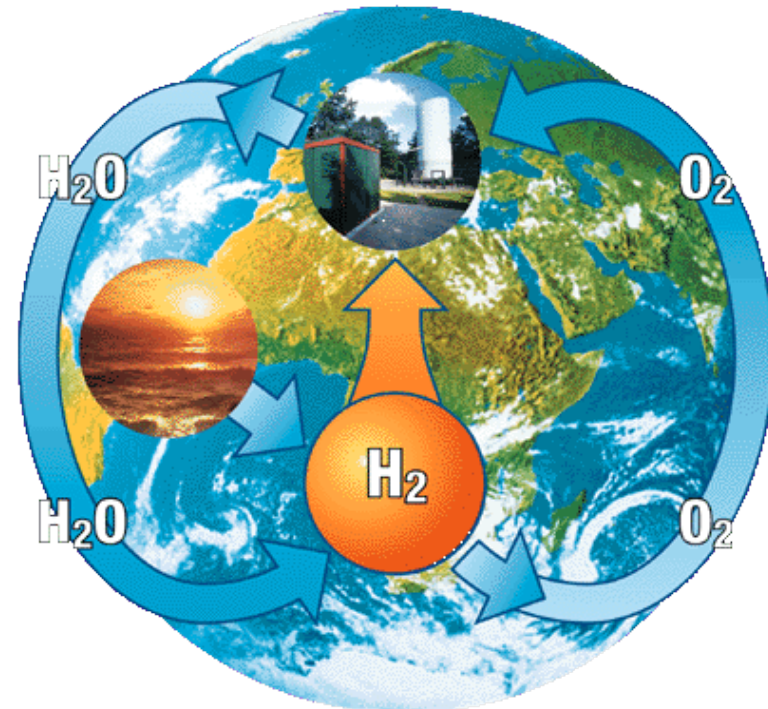
ΝΟΜΟΣ ΥΠ' ΑΡΙΘ. 4439 ΑΡ. ΦΥΛΛΟΥ 222
Ενσωμάτωση Στην Ελληνική Νομοθεσία Της
Οδηγίας 2014/94/ΕΕ του Ευρωπαϊκού
Κοινοβουλίου Και Του Συμβουλίου Της 22
Οκτωβρίου 2014 Για Την Ανάπτυξη Υποδομών
Εναλλακτικών Καυσίμων, ...

ΓΙΑΤΙ ΥΔΡΟΓΟΝΟ;

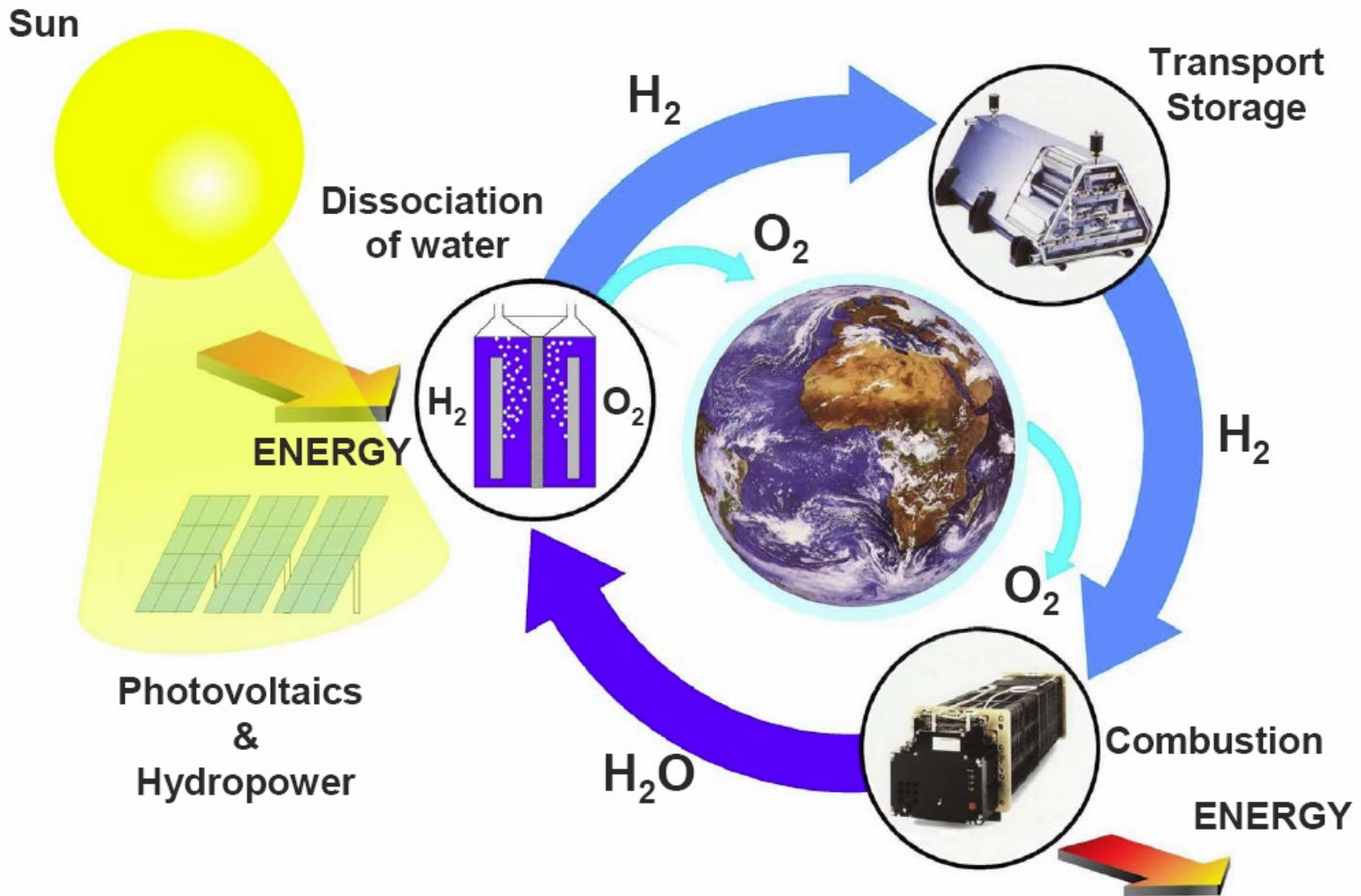
- Το υδρογόνο έχει το υψηλότερο ενεργειακό περιεχόμενο ανά μονάδα βάρους από οποιοδήποτε άλλο γνωστό καύσιμο, **120.7 kJ/gr** και περίπου τρεις φορές μεγαλύτερο από αυτό της συμβατικής βενζίνης.
- Κάνει "καθαρή" καύση. Όταν καίγεται με οξυγόνο παράγει μόνο νερό και θερμότητα και δε συμβάλλει στη μόλυνση του περιβάλλοντος.



The only
waste
product
is
water



Ο κύκλος του Υδρογόνου



ΥΔΡΟΓΟΝΟΚΙΝΗΤΑ ΟΧΗΜΑΤΑ

**GROUND UP ZEV FUEL CELL VEHICLE
(Gaseous H₂ Tanks)**

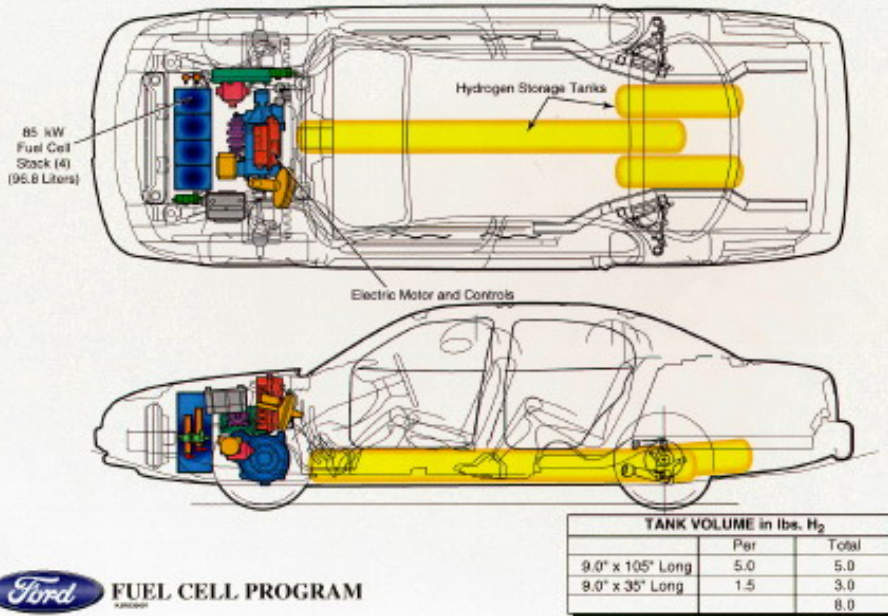


Figure 1. A conceptual fuel cell vehicle fueled with 5,000 psi hydrogen stored in carbon fiber-wrapped tanks



WHAT IS A FUEL CELL VEHICLE (FCEV)?

An EV drive train that's refuelled rather than recharged

- Refuel in 3 mins
- Range >300 miles

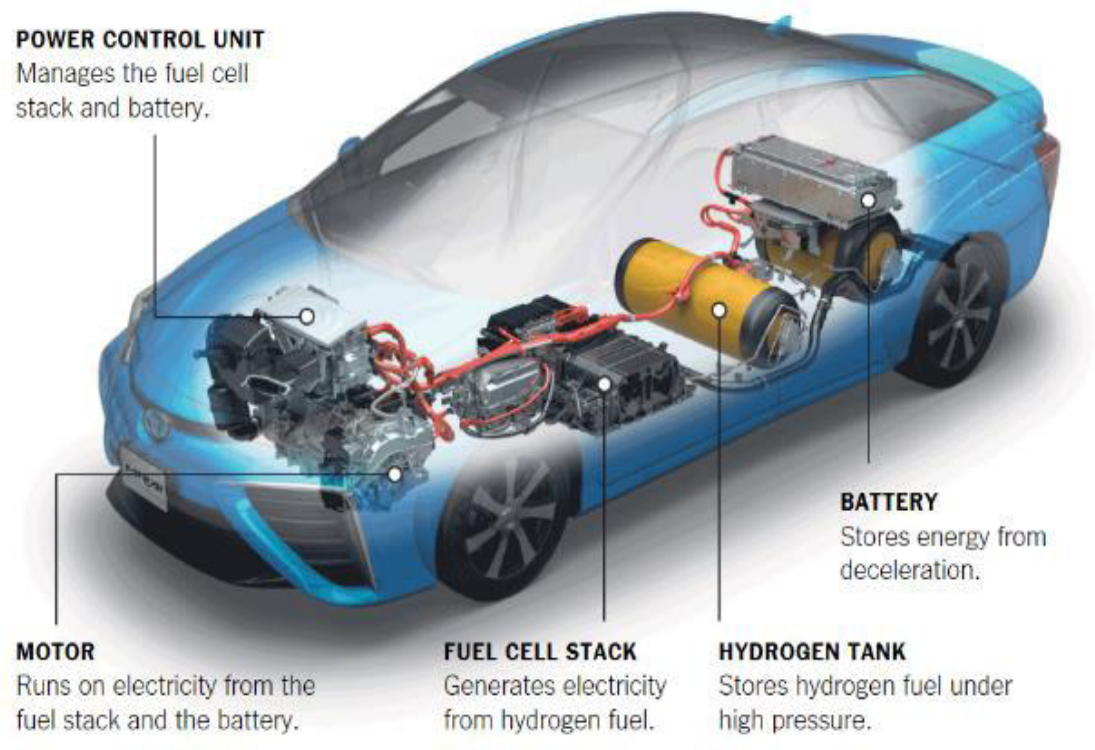
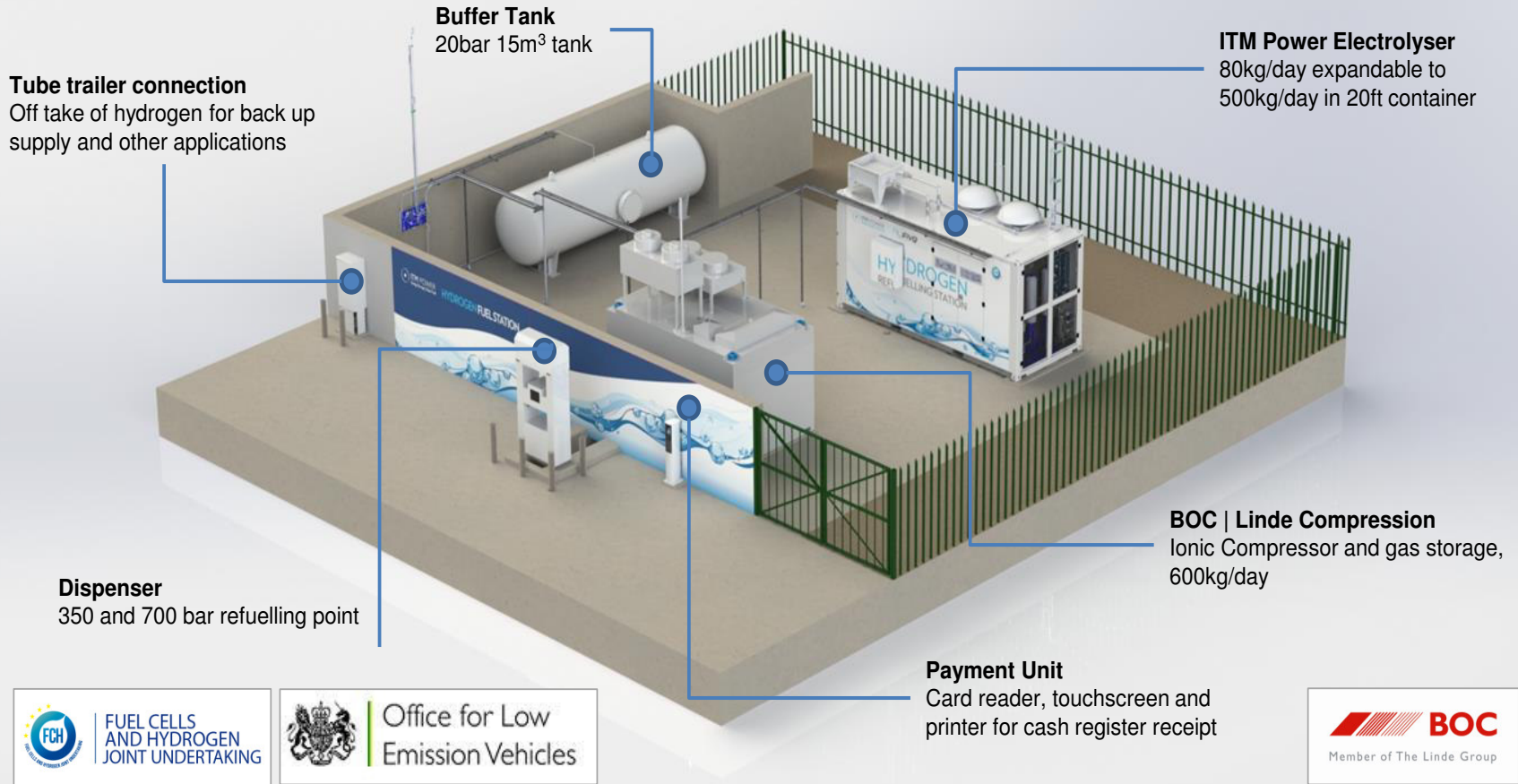


Image by Toyota

FUEL CELL VEHICLES
ENERGY STORAGE | CLEAN FUEL

WHAT IS A FCEV REFUELLING STATION?



FCEV REFUELLING STATION
VEHICLES | ROLL OUT

TOYOTA MIRAI



Το πρώτο όχημα με
κυψέλες υδρογόνου
κυκλοφορεί στους
δρόμους!



ΜΗΔΕΝΙΚΕΣ ΕΚΠΟΜΠΕΣ ΡΥΠΩΝ



ΣΥΝΟΛΙΚΟΣ ΧΡΟΝΟΣ ΓΕΜΙΣΜΑΤΟΣ

3 ΛΕΠΤΑ



ΑΠΟΣΤΑΣΗ ΑΝΑ ΓΕΜΙΣΜΑ

500 ΧΙΛΙΟΜΕΤΡΑ

THE FCX PROJECT BY HONDA

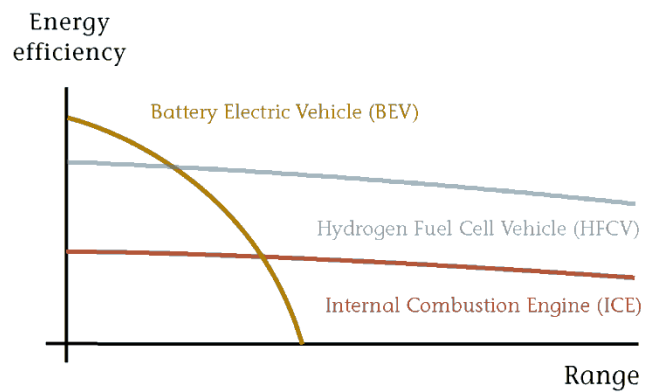


Honda FCX Clarity 2008

The big advantage over plug-in electric vehicles is **range**

The FCX will do around 270 miles on a four-kilo tank of hydrogen!

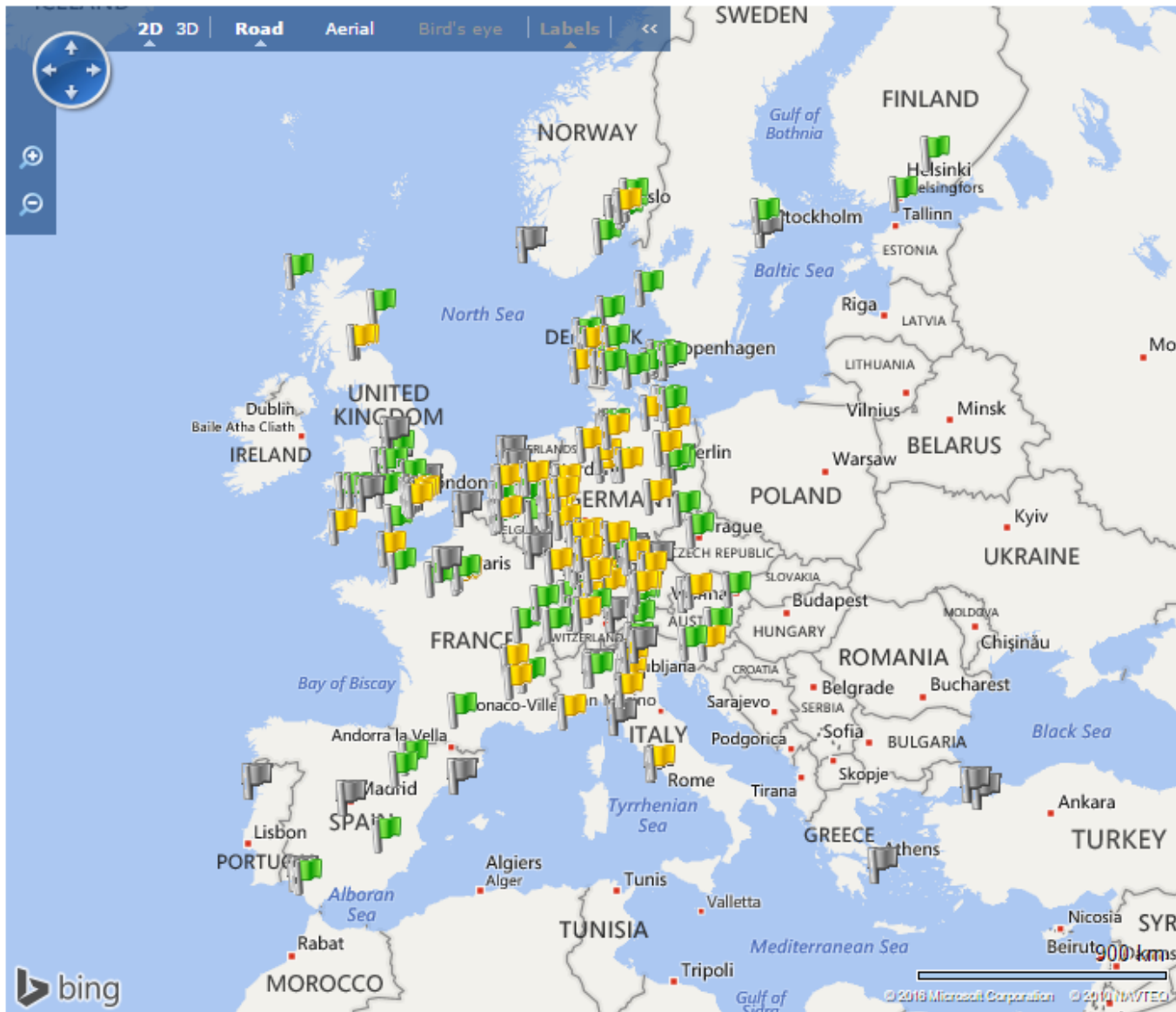
THE RIVERSIMPLE VEHICLE (UK)



A figurative diagram showing efficiency v range



Hydrogen Filling Stations in Europe



Km Miles

in operation

planned

old projects

© Copyright Ludwig-Bölkow-Systemtechnik



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Fuel Cell Buses: Status in Europe

CARLOS NAVAS

Athens, March 1st 2018



As clean as electric, as flexible as diesel...



Clean



Performance



High passenger comfort



High daily ranges



Ready to buy



Fast refueling



Full route flexibility



Examples of Available Buses



Van Hool



Wright



HyMove



Wright



Buses deployment

From testing the technology to widespread deployment



CHIC
2009
#26 BUSES

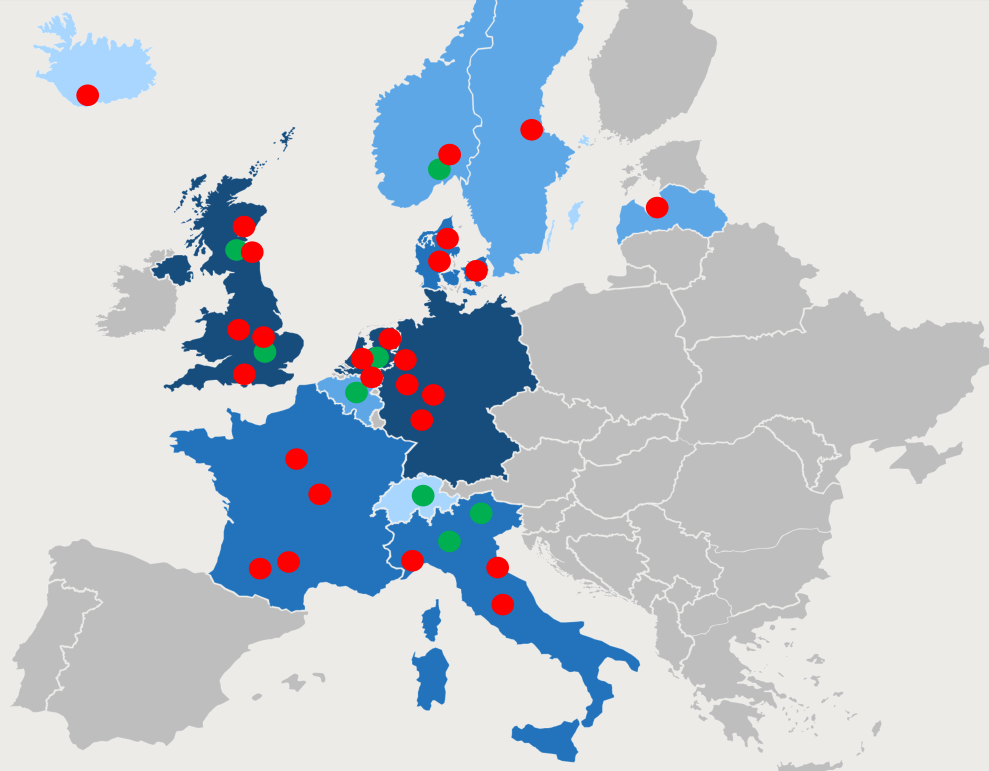
HIGH V.LO-CITY
2010
#14 BUSES

HYTRANSIT
2011
#6 BUSES

3EMOTION
2013
#21 BUSES

JIVE
2016
#139 BUSES

JIVE2
2016
#152 BUSES



● DEPLOYED ● PLANNED

0-5 6-15 16-45 46+

of units

Buses: A flexible competitive clean solution

Europe is world leader



Achieved

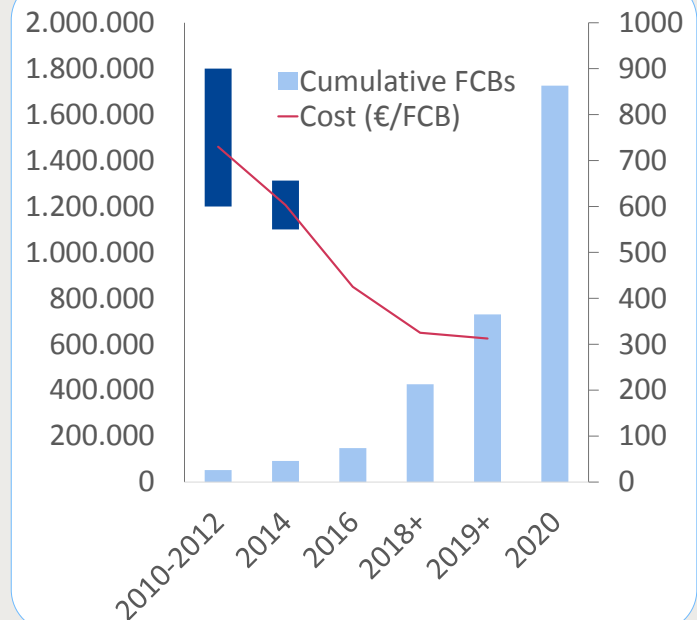
- >5,000,000 km driven since projects started
- > 300,000 h of operation
- >159 tn of H₂ consumed only in 2016

Pre-commercialisation phase

- 25,000 h lifetime reached
- Availability proven but with teething problems
- 650,000 €/bus offered
- Average 9.86 kg/100km (very dependent on city)

Challenges

- Mature supply chain to ensure availability
- Continue reducing the price of the bus
- European fuel cell supplier



Cost of Ownership: a comparison

Comparison of TCO

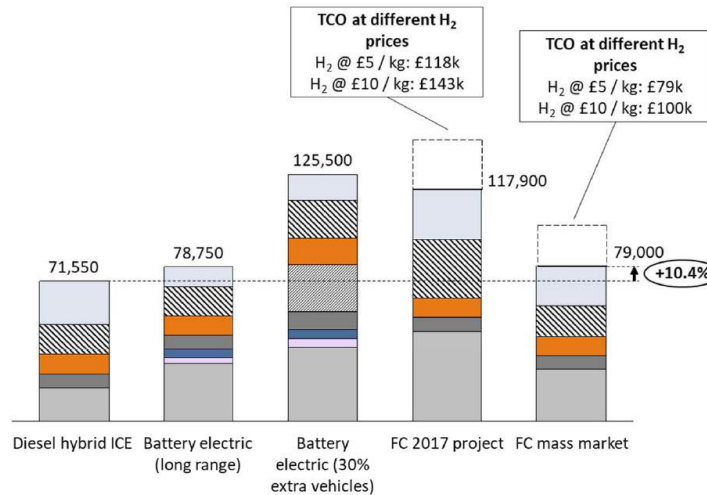


Single decker bus annuitized ownership cost analysis

GBP per year – annuitized over 14 year lifetime



- Additional H2 cost (@£10 / kg)
- Fuel costs
- Bus drivetrain maintenance costs
- Bus regular maintenance costs
- Additional bus driver costs
- Depot overhead costs
- Infrastructure capex
- Infrastructure maintenance costs
- Bus capex



Note: the "30% extra vehicles" case is based on more buses being needed to compensate for the extra charging time required during the day due to the limited range of battery electric buses.

Source: Element Energy

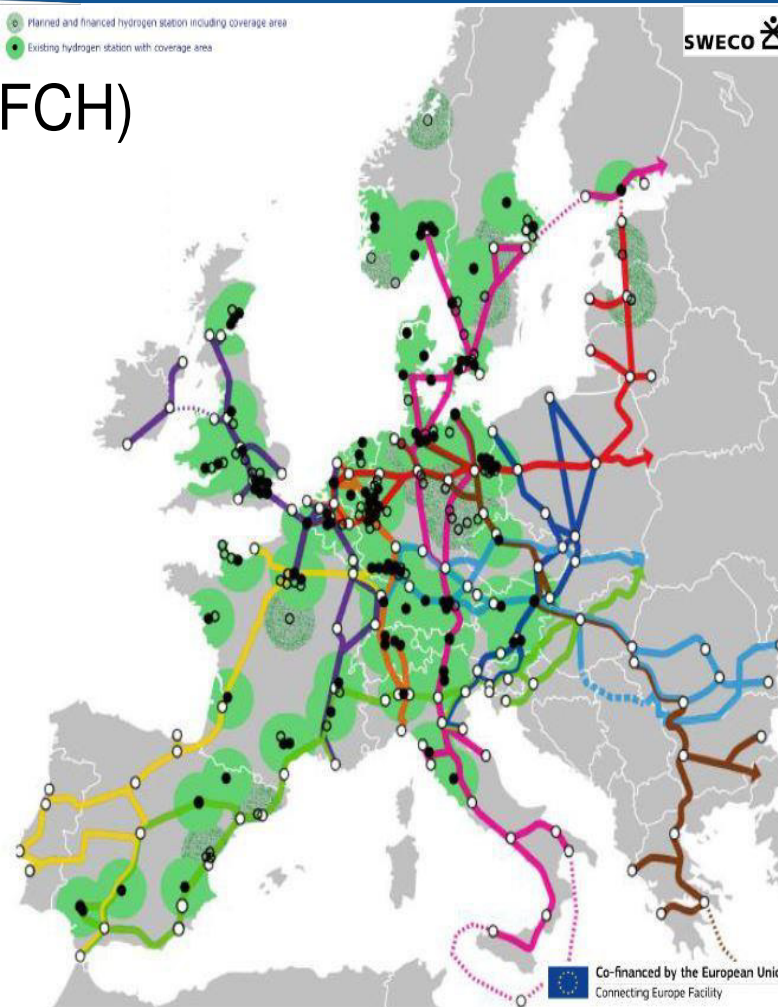


● EC Focus Hydrogen-Electric (FCH)

- The great work of the FCH-JU (H2020 & Industry): RTD
- TEN-T & CEF: Deployment (mainly infrastructure, but also increasingly vehicles)
 - to trigger market (chicken & egg problem!).
- 11 real life transport trials (T) & 1 synergy trial based on H2 storage (T&E)
- Recent CEF impact on H2 for Europe:
 - » T&E: real-life trial "TSO2020" (NL) (Grant call Sept'2016)
 - » T: real-life trial "H2Benelux" (BE, LU, NL) (Grant call end'2016)
 - » T: real-life trial "Nordic H2 Corridor" (SE) (Grant call end'2016)
 - » T: roll-out "Zero Emission Valley" (FR) (Blending call 2017 DL1 (*))

Need more H2 roll-out proposals to 2.DL of CEF Blending Call (infra & vehicles)!

(* EC Selection Decision of 05/01/2018 (adoption) – i.e. not in map



125 H2 stations operational by end 2017; expand to 350 by 2020 (already planned & financed, but without results of CEF blending call, because contract is not signed yet).



BMW - Hydrogen 7



Honda - FCX Concept



G.M. - HYDROGEN3

Ευχαριστώ



Ford - H2RV



H2-powered MINI



G.M. - HUMMER H2H



Toyota - FCHV



Shelby Cobra