FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Trials and deployment of fuel cells applications - TRANSPORT

Lionel BOILLOT

PRD 2018

14 November 2018

Agenda

PROGRAMME REVIEW DAYS 2018
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING
14 - 15 NOVEMBER, BRUSSELS

	TRIALS AND DEPLOYMENT OF FUEL CELL APPLICATION - TRANSPORT	NEXT GENERATION OF PRODUCTS - TRANSPORT	TRIALS AND DEPLOYMENT OF FUEL CELL APPLICATION - ENERGY	NEXT GENERATION OF PRODUCTS - ENERGY	HYDROGEN FOR SECTORIAL INTEGRATION	SUPPORT FOR MARKET UPTAKE
09:00 - 09:20	H2ME HAWL HYFIVE HYLIFT-EUROPE HYTRANSIT JIVE SWARM H2ME 2	AUTO-STACK CORE COBRA COSMHYC DIGIMAN Fit-4-AMandA H2REF HYCARUS INLINE INN-BALANCE INSPIRE MARANDA NANO-CAT SMARTCAT VOLUMETRIQ COMPASS Giantleap	ALKAMMONIA AUTORE CH2P CLEARGEN DEMO D2SERVICE DEMCOPEM-2MW DEMOSOFC ENE.FIELD ONSITE PACE PEMBEYOND POWER-UP STAGE-SOFC	Cell3Ditor DIAMOND ENDURANCE FLUIDCELL HEALTH-CODE HEATSTACK INSIGHT MATISSE NELLHI PROSOFC qSOFC SCORED 2:0 SECOND ACT SOSLeM INNO-SOFC	BIONICO BIOROBURplus Demo4Grid DON QUICHOTE Eco ELECTRA ELY4OFF ELYntegration GrInHy H2Future HELMETH HPEM2GAS HyBalance HYDROSOL-PLANT HyGrid INSIDE MEGASTACK PECDEMO PECSYS QualyGridS SElySOs SOPHIA BIG HIT MEMPHYS	HYACINTH HYCORA HyLAW HYPACTOR HySEA HYTECHCYCLING KNOWHY NET-Tools SOCTESOA
09:20 - 09:40						
09:40 - 10:00						
10:00 - 10:20						
10:20 - 10:40						
10:40 - 11:00						

ıs in Regional

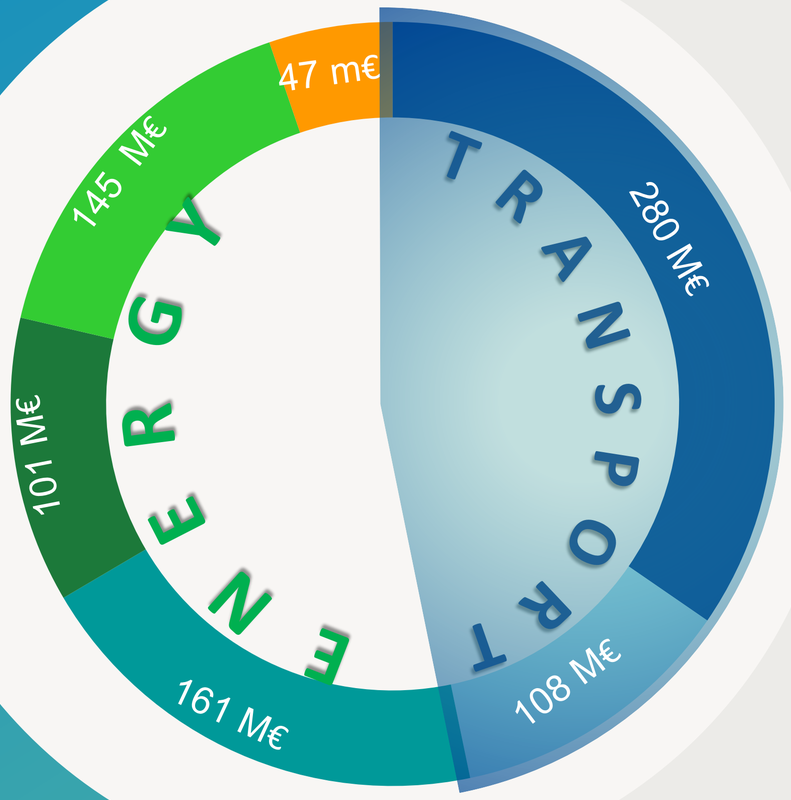
g vehicles

Trials and Deployment of Fuel Cells Application-Transport

Related FCH JU objectives

Reduce fuel cell system costs for transport applications while increasing lifetime

Reduce use of critical raw materials



Transport - Total

42 %

388 M€

60 Projects

Out of which

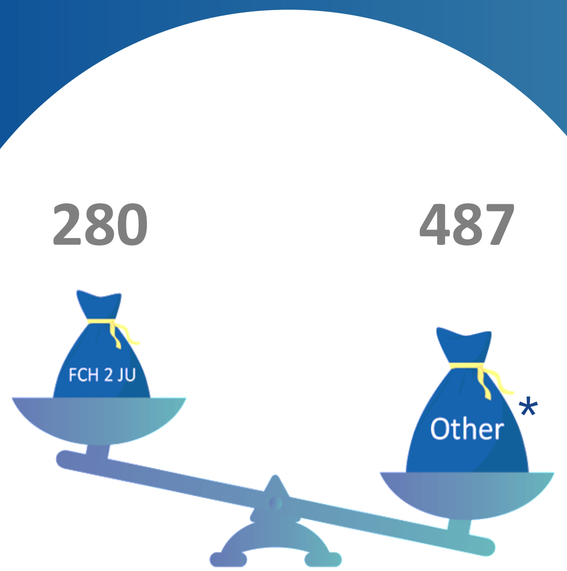
Transport Deployment

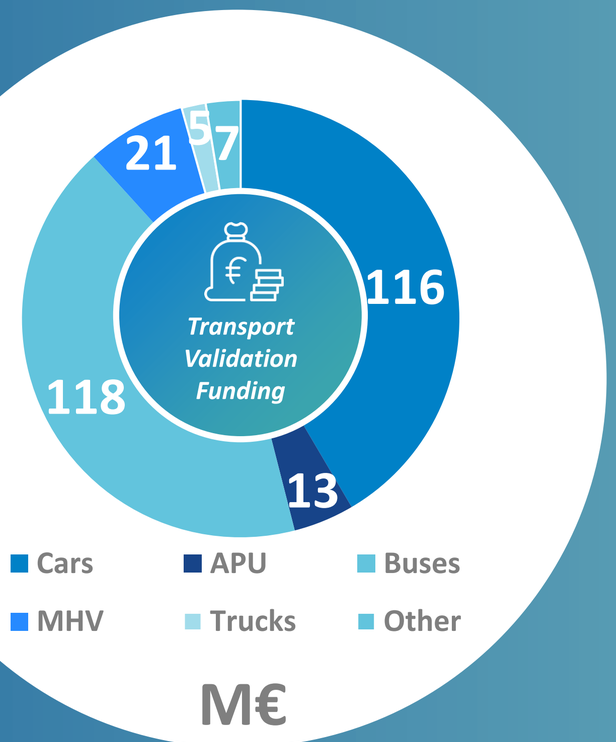
280 M€

28 Projects

On the road to widespread deployment

28 projects –767 M€





Extending the European network

Consolidating as market alternative

First steps to EU business case

DEPLOYING:

100 HRS

1,900 cars

360 buses

280 MHV

15 trucks

** Other resources including private and national/regional funding*

Putting the numbers in the streets

Seven models on the road today

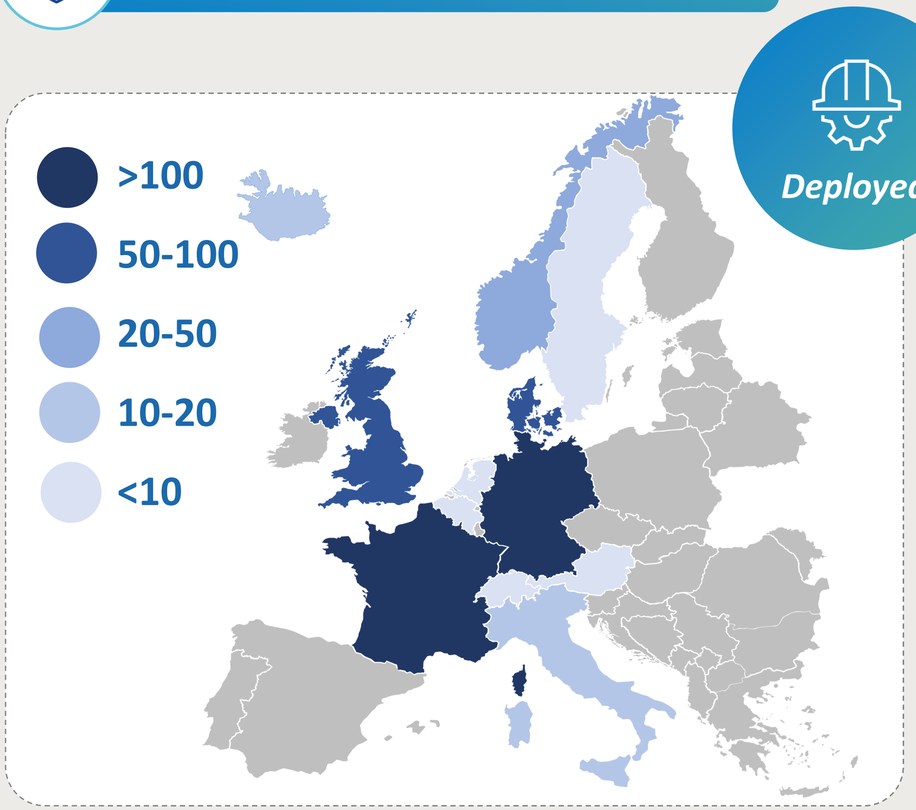
Deploying along the full European geography

11 countries to deploy vehicles within our projects

625 cars deployed

Year (call)	*Projects*	*#FCEV*	*Already deployed*	*Countries*
2008	**H2MOVES**	19	19	2
2010	**Hytec**	24	24	3
2011	**SWARM**	35	13*	3
2013	**Hyfive**	133	133	6
2014	**H2ME**	325	245	9
2015	**H2ME 2**	1109	136	10
2015	**BIGHIT**	10	5	1
2017	**ZEFER**	180	50	3

Availability close to 100%



Finished projects are underlined

* SWARM will complete deployment by Q1 2019

Cars and small vans are at commercial standards

New car models are coming in the roads

Achieved in 2017
- > 1,830,000 km driven
- > 24.5 t of H_2 consumed in 2017

Product ready for commercialisation
- Up to 594 km of driving range
- 99.3 % availability
- 1.3 kg/100km average consumption

Challenges
- Few choices in the market
- Cost

Fleet validation on-going

New FCEV models coming

Increase HRS usage!

Concept cars

FCEV-RE

Innovation Award Nominees

FCEV

Fleet operation – example of H2ME projects

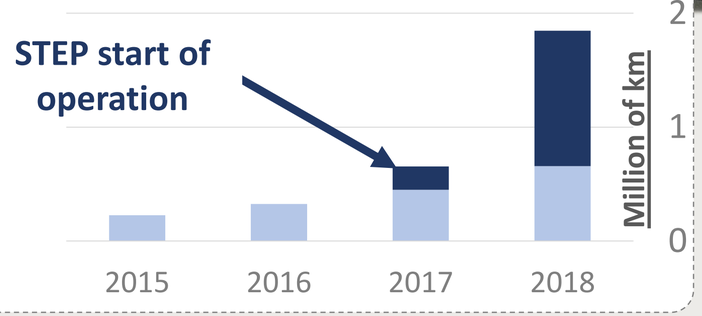
Demonstrating the efficiency of the technology – Vehicles and HRS pushed to intensive conditions

Taxi fleet (STEP) in Paris

- July 2017 – Sept. 2018: furthest distance travelled by one of the vehicles is 72 836km since July 2017
- ~ 4-6.000km/month/taxi in Paris
- 2 shifts/day operation

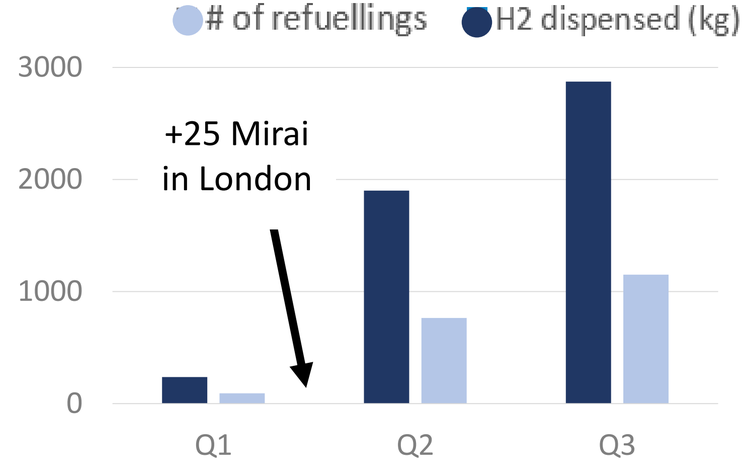
H2ME

Vehicle usage in fleet operation



85%
green hydrogen

HRS response to fleet operation (2018)



Police vehicles (MOPAC) in London

- Involved in police operations
- … including crashes

HRS high quality service required

- Upgrade of HRS
- Constant use over the day – like gasoline station
- Integrated in gas station forecourt
- Back-to-back refill
- Proprietary « App » for HRS status

Reaching the market phase

Offering a flexible clean competitive public transport solution

More cities, larger fleets, more suppliers: approaching market stage

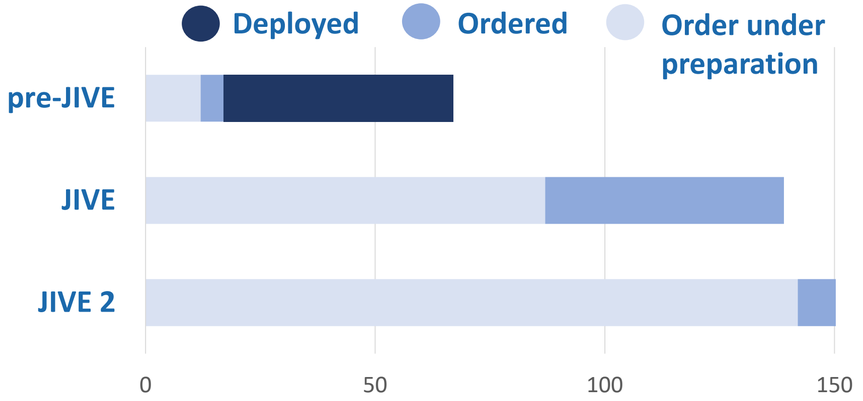
Need to fulfill the project plans, buses are covering the European territory

From order to operation, a delivery time ~ 18 months

CEF and EIB support FCB deployment

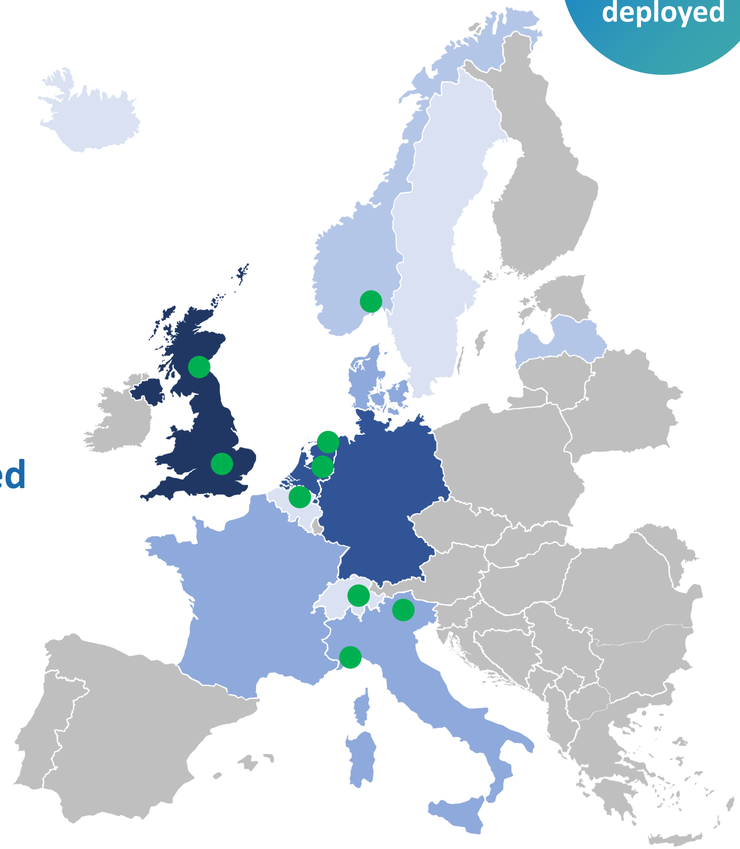
50 FCB on the road

Buses deployment status



Buses deployment geography

Planned and deployed



Flexible bus design and lenghts

New OEM involved

Next generation products

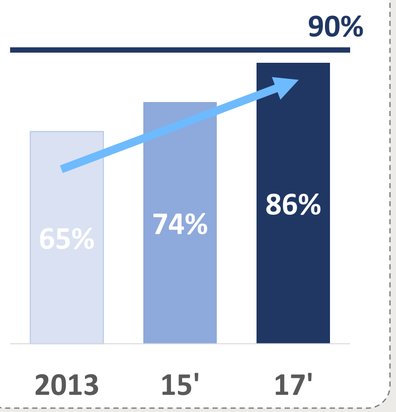
A flexible competitive clean solution

Europe is world leader

Achieved
- > 6,000,000 km driven since projects started
- > 92 t of H_2 consumed only in 2017
- > 25,000 h lifetime reached
- 625,000 €/bus offered

88% ***green hydrogen***

Average availability

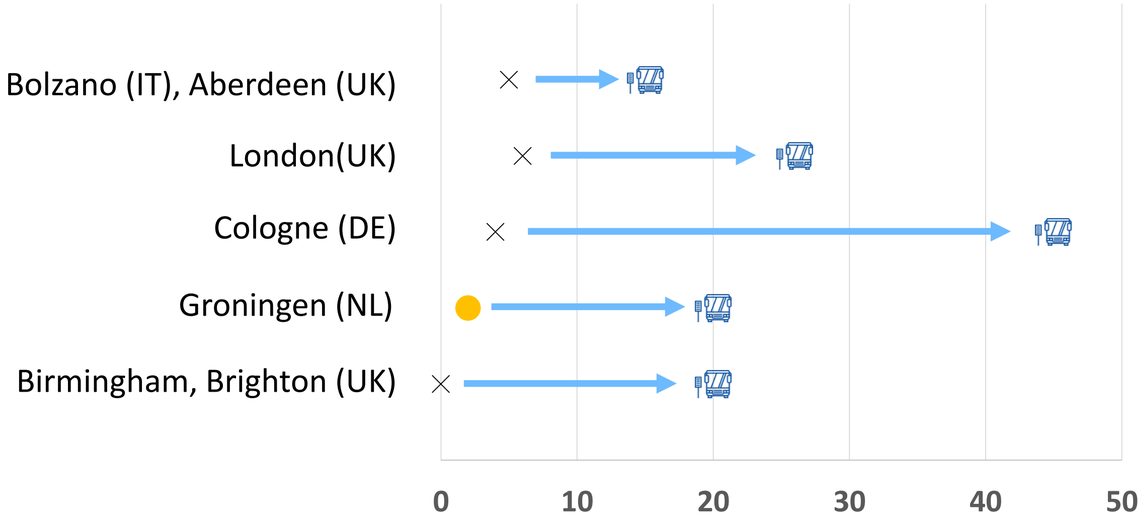


Reduction of downtime by:
- Easier access to spare parts
- Integration of FC maintenance in bus preventative schedule
- Dedicated pits at bus depots
- Presence of OEM staff on-site

Cities order fleet of buses

Increase of scale of bus orders

X : in 2013/14 ● : in 2017 : in 2018/19



Questions for the audience

Learning from HyTransit

Take your smartphone; go to www.sli.do and insert the code #PRD2018

In comparison to diesel Euro VI buses, how many tons of CO2 were saved from March 2015 to September 2018 through the use of 6 Fuel Cells buses in Aberdeen ?

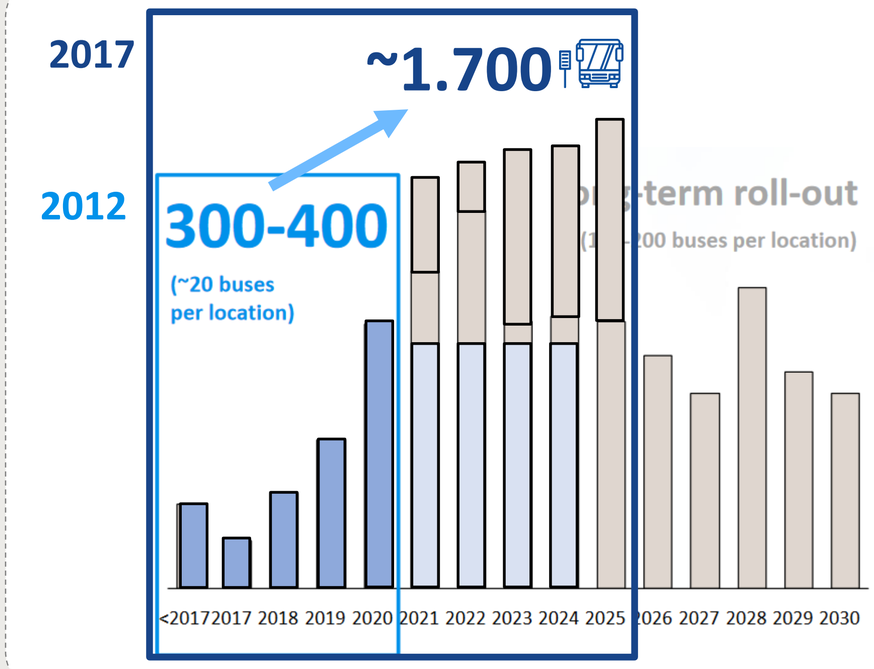
The buses are powered by green H2.

a. 10 tons ?
b. 100 tons ?
c. 500 tons ?
d. 1.000 tons ?

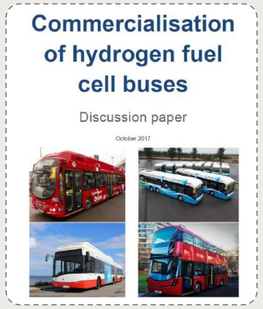
Not only projects but a full strategic development

Results of study support since 2012 and strategy forward

Clockwise implementation of the identified deployment potential



New business and financing models
- Joint procurements
- Central purchase office
- Special Purpose Vehicle



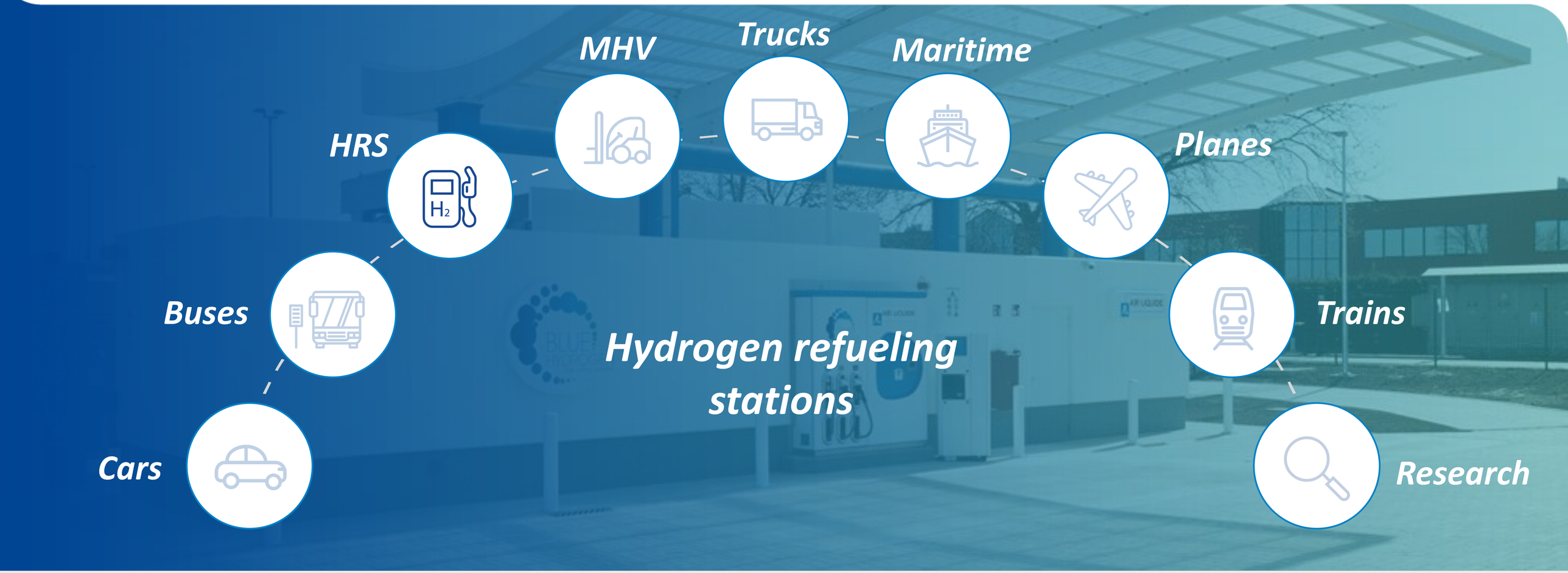
Policy for funding mechanisms
- Discussion paper for policy purpose

Dissemination
- Workshops and conferences
- **Zero Emission Bus conference**

2018 EUROPEAN ZERO EMISSION BUS CONFERENCE
Cologne • November 27th & 28th

Paving the way for FCEV deployment in Europe

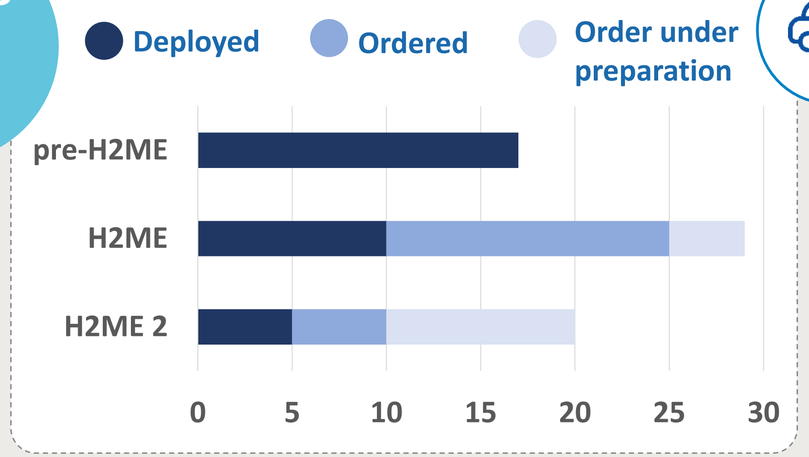
Exporting technology

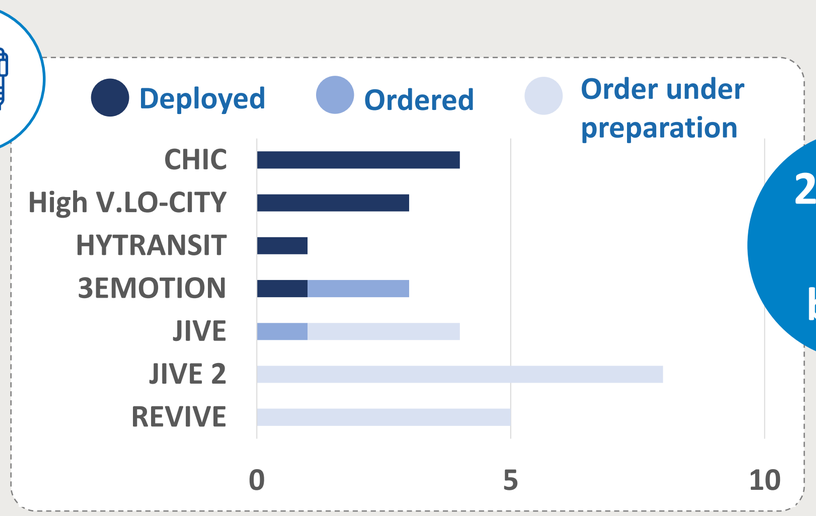


Making FCEV deployment possible

13 countries involved in HRS deployment

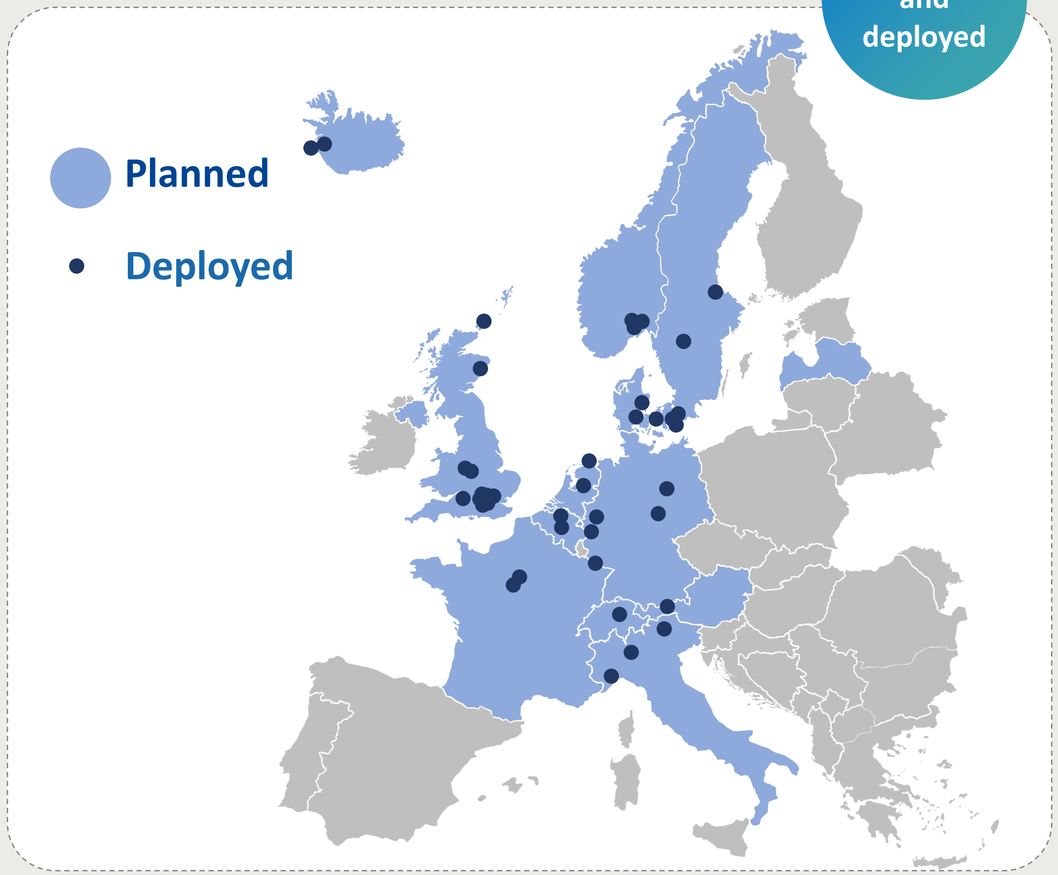
67 HRS for cars





28 HRS for buses

Planned and deployed

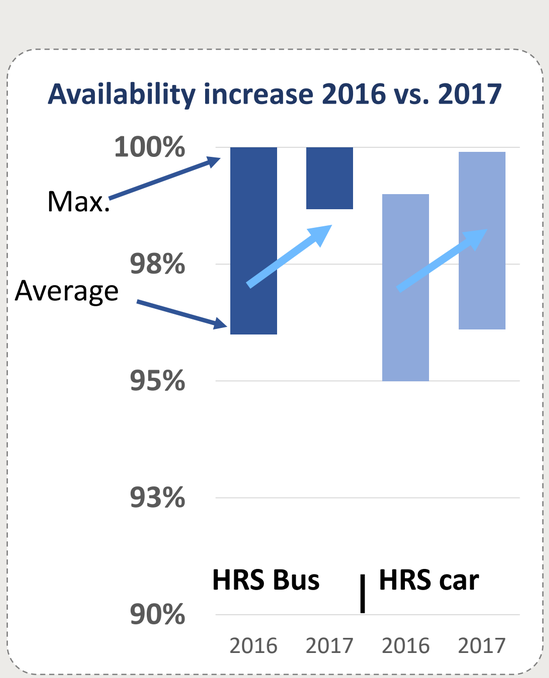


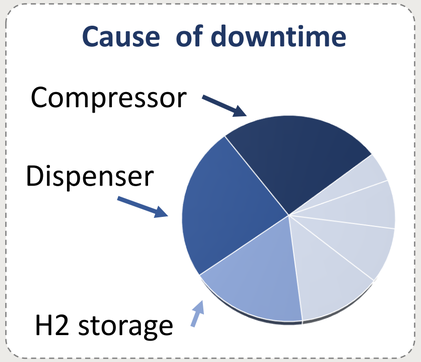
CEF supports HRS deployment as well

Developing technology for everyday customer

Generating revenues vs. covering territories

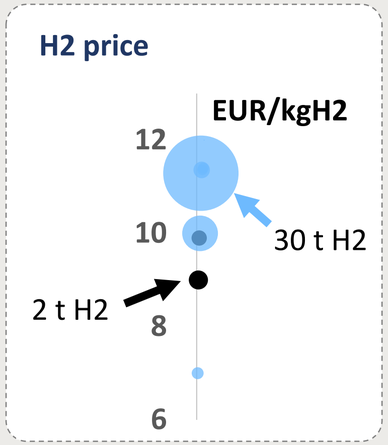
Achieved
- >39,000 refuelling operations in 2016
- > 308 t H2 dispensed
- Permitting down from 24 to 18 months





New revenue models
- H2 injection in gas grid
- Electricity for grid balancing

Challenges
- Reaching profitability
- Surviving underutilization
- Reducing energy consumption
- Standardisation



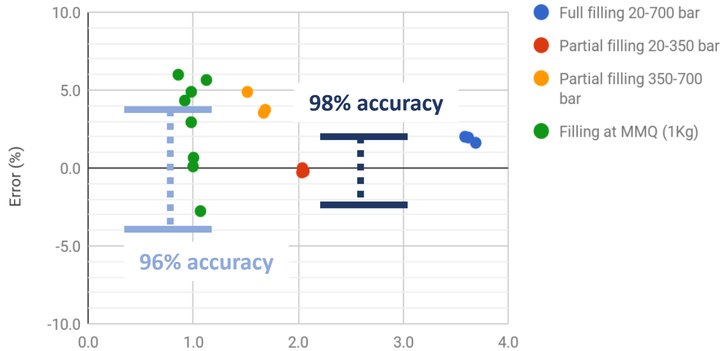
Trends and context
- Coherence of national deployments due to AFI directive
- H2 dispensing within petrol station forecourt
- Market consolidation in some areas
- Improved customer experience
- Hand by hand HRS with fleet deployment

HRS service is getting closer to commercial operations

Metering accuracy and open source for public HRS online monitoring in all EU countries

Expectation for commercial operations = ability to **measure accurately** the amount of hydrogen dispensed

Field tests and measured accuracies



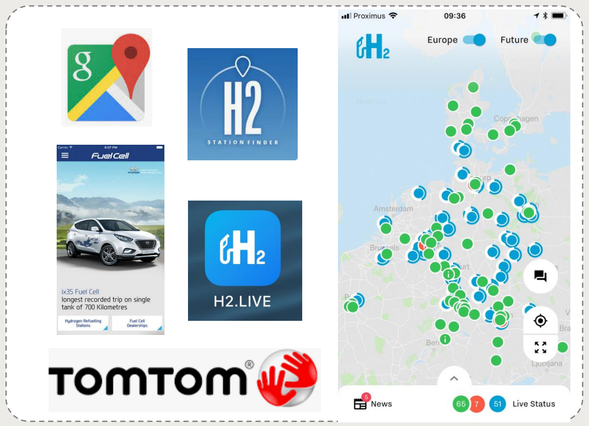
Development of a system for HRS availability in the EU

Data collection

https://h2-map.eu/

Status definition

Possible end users



First steps into the business case

Expanding the fleets giving answers to the market

First steps to develop a European business case for forklifts

Looking into market diversification and new segments

First greenfield warehouse and the largest fleet in Europe

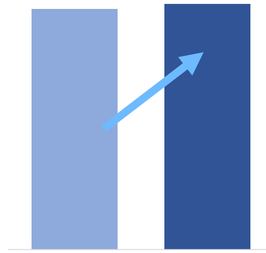
Large fleet

Diversity of vehicle types

Delivery as a service

Achievements since 2016
- 226 MHVs in 3 warehouses
- > 87.000 refuelings
- > 600.000 hours of operation
- Publication of regulation for warehouse H2 operations: ease replication (FR)

Availability increase

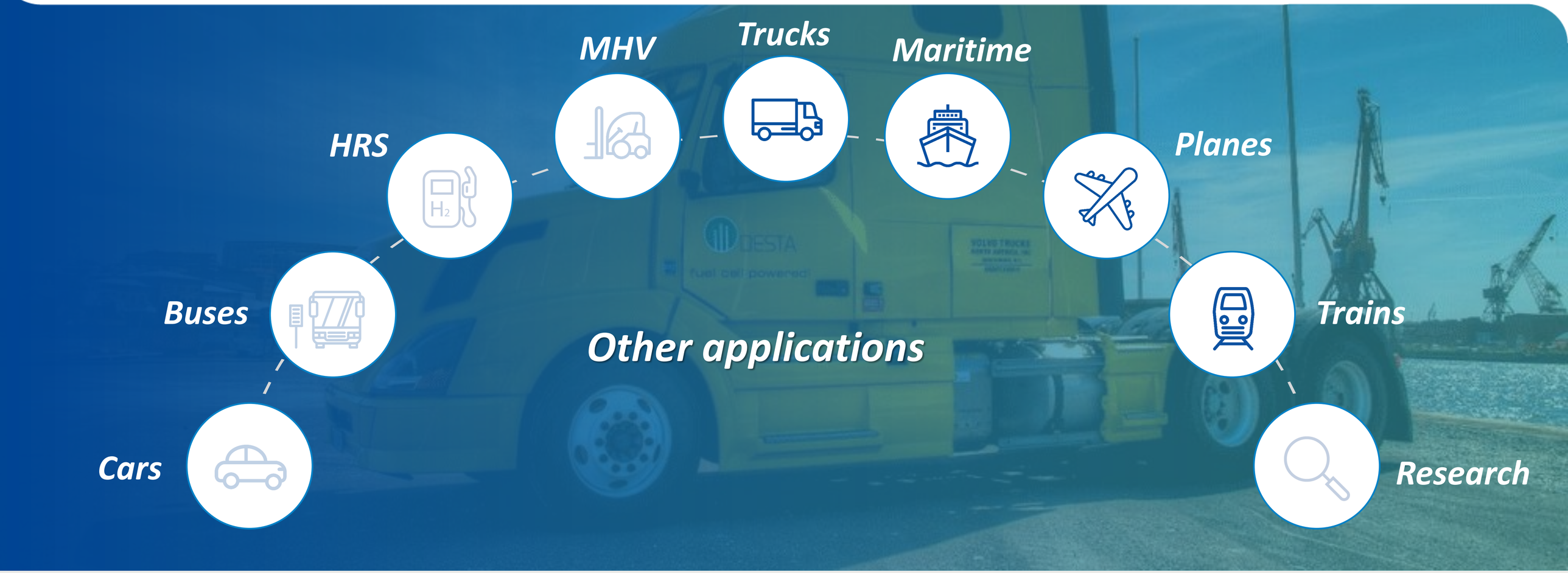


A complete solution “vehicles + H2” to :
- Reach TCO and generate profits
- Brings flexibility for the operations
- Reduces risk
- Limit footprint loss for refuelling

Opportunities
- Logistics beyond the warehouse
- Port applications

Reaching out to cover all transport applications

Testing the technology, broadening its application



Supporting the growing sectors of heavy duty trucks and maritime

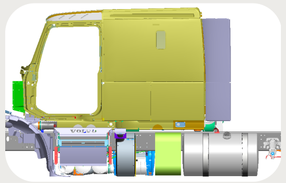
Continuum of funding in the best fit for business case

2018 – Fleet of HD trucks

Large scale heavy duty trucks

2017 – 15 Garbage trucks

2013 - APU development for diesel truck



Up to scale

Key considerations
- Non-European OEM pressure
- Diverse operations (last mile, long haul, urban or interurban)

Growing sector

2018 - Ferry propulsion

Mid-size passenger ships and inland freight

2016 - Dynamic positioning

2013 - APU for recreational yachts

Key considerations
- Importance of regulatory aspects
- FC for hotel load at port or propulsion at sea
- Going towards MW scale FC
- Hydrogen logistics and storage

Identifying and supporting the uptake of H2 for trains and aircrafts

Continuum of funding in the best fit for business case

Identify best scenario

On-going cooperation “Study on use of fuel cell hydrogen in railway environment”

Going beyond regional trains
- Shunting locomotive, DMU
- TCO calculation
- Environmental impacts
- Multimodal approach

Towards aircraft propulsion

2018 – Aircraft propulsion

Emission-free regional 19 seater aircraft

2017 – FC for emergency operation

2012 - APU for secondary electrical system

Key considerations
- Specifics safety measures
- Regional aircraft (up to 19 passengers) as a market
- Weight, sound and pressure demanding application

Decarbonizing the European transport sector

Allowing to meet the European CO_2 targets

- Advancing on “fleet case” deployments
- Towards larger fleets demand
- Spreading and speeding H2 mobility
- Expanding business cases and reaching out new markets
- Supporting the first best fit per application

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FCH JU

Questions for SLIDO

Learning from HyTransit

In comparison to diesel Euro VI buses, how many tons of CO2 were saved from March 2015 to September 2018 through the use of 6 Fuel Cells buses in Aberdeen ?

The buses are powered by green H2.

~~a. 10 tons ?~~
~~b. 100 tons ?~~
~~c. 500 tons~~ ?
d. 1.000 tons ?

- 1.2 million km travelled since March 2015
- Diesel consumption is 33 litres/100km
- 2.6kg CO2 equivalent/litre of diesel (based on emissions factor from BEIS)

1.000 tons of CO2 = 396.000 litres of diesel