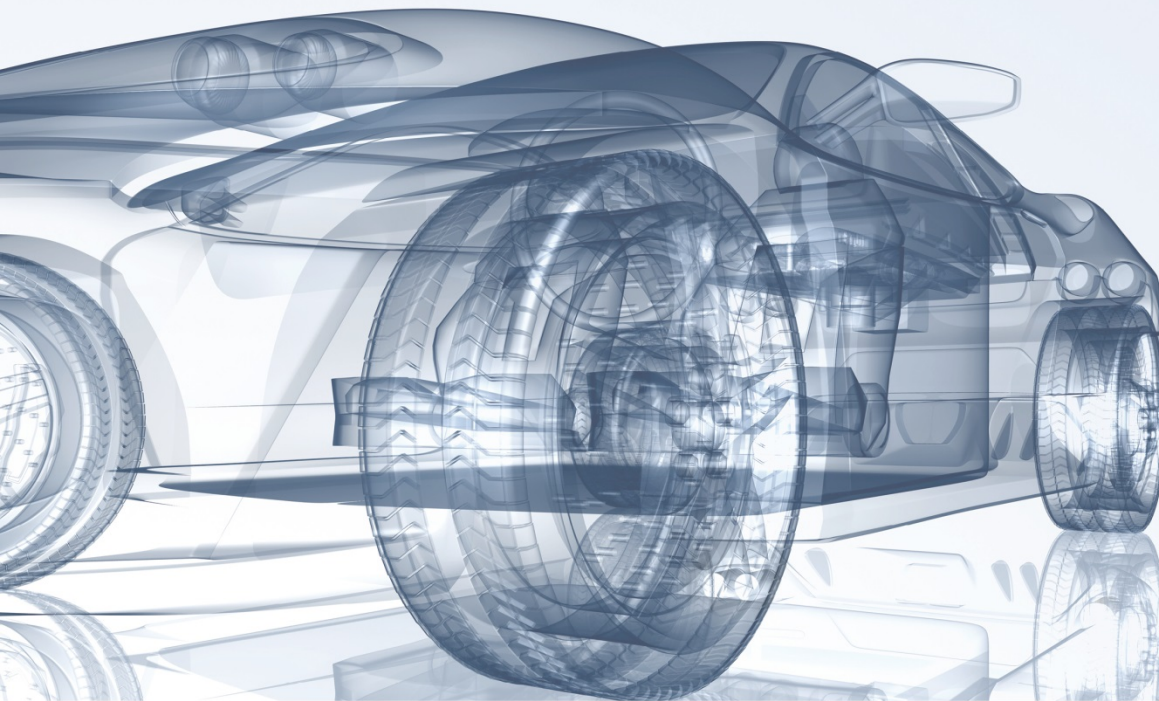


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# **A European Approach for the Commercialization of Fuel Cell Buses in Public Transport**

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## Agenda

**1**

Characteristics of Fuel Cell Buses

**2**

FC Bus Activities in Europe

**3**

Summary

# Advantages of Fuel Cell Buses



## Performance

... comparable to diesel buses in terms of acceleration and gradeability



## High passenger comfort

... because of low noise and zero emissions



## High daily range

... of 400 km without refuelling – extension possible



## Full route flexibility

... not bound to any infrastructure along the route



## Fast refuelling

... in seven minutes – also several times per day, no impact on procedures at depot



## High technical maturity

... with 10 years and 5.5 mio. km experience in Europe

## Agenda

1

Characteristics of Fuel Cell Buses

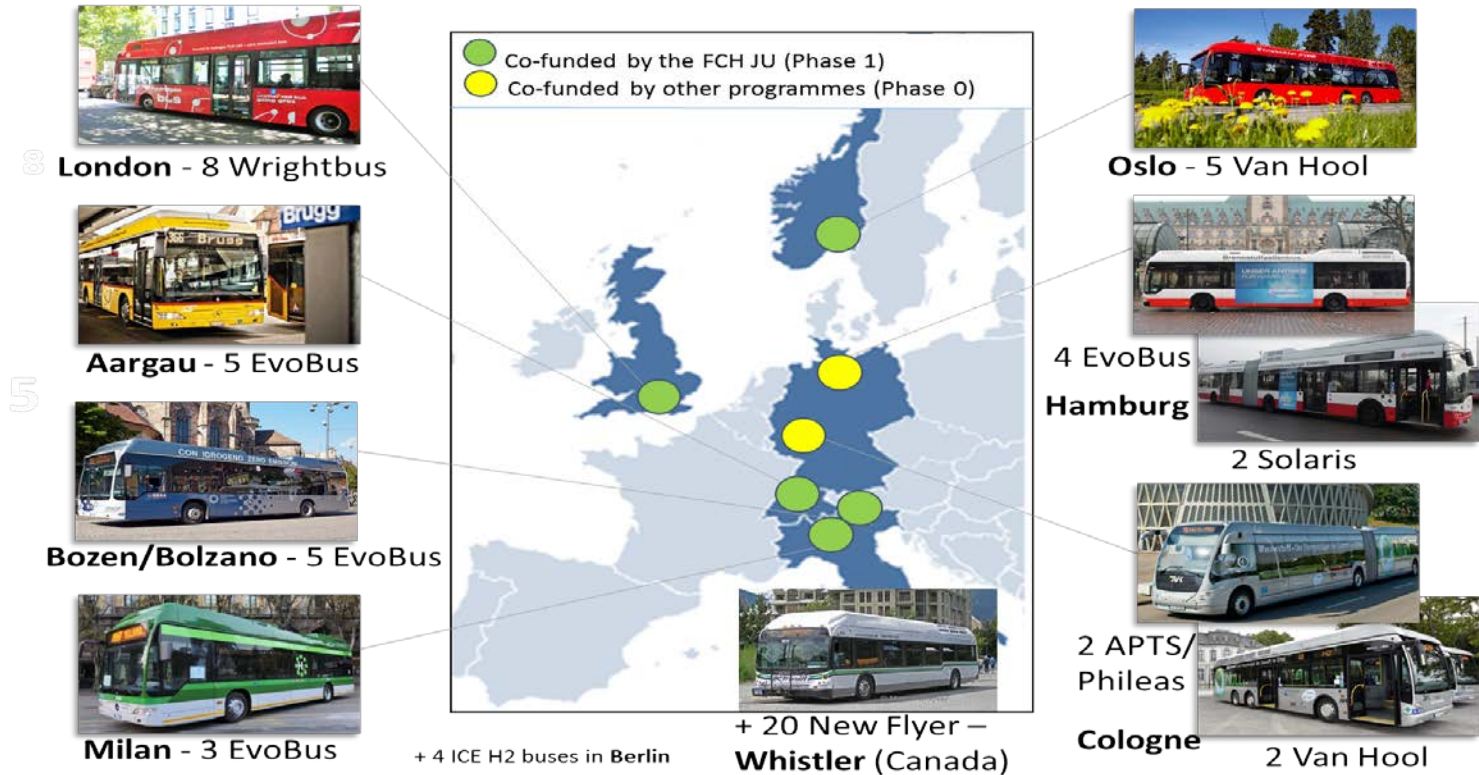
2

FC Bus Activities in Europe

3

Summary

# CHIC delivered 56 fuel cell buses from 6 different bus OEMs in 8 cities plus significant improvements



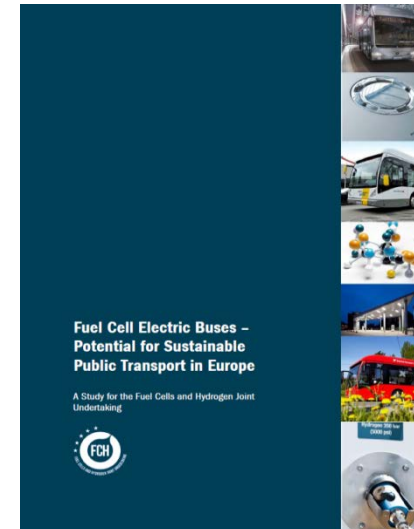
Together with other projects: 80 buses on European roads

## Next Approach: EU Fuel Cell Bus Coalition



83 members, thereof:

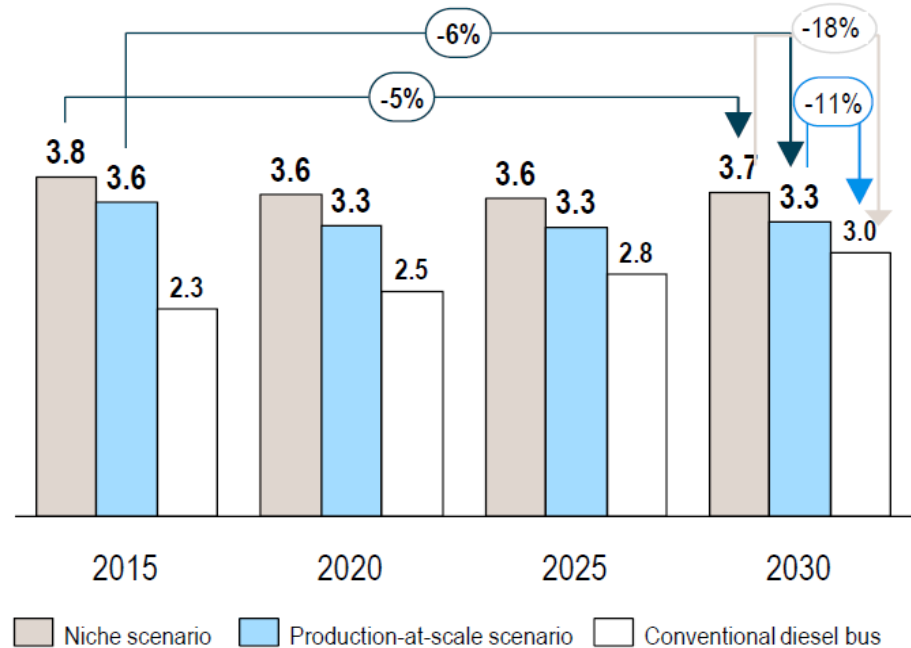
- 35 PTO from 12 countries
- 7 bus OEMs
- 4 fuel cell companies
- 2 electrolyser manufacturers
- 10 Infrastructure- / H<sub>2</sub>-providers



## Main Results of the Study

Cost gap compared to diesel buses can be reduced to 10-18 %, assuming

- lower hydrogen and higher diesel prices
- high number of FC buses
- making use of synergies by using FC stacks from automotive industry
- reduction of infrastructure costs



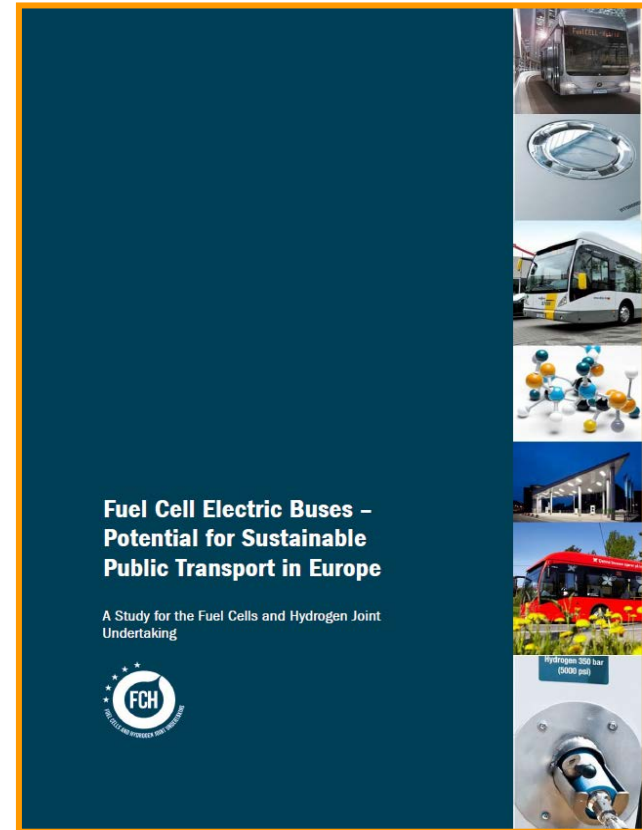
Source: FCH JU study: "Fuel Cell Electric Buses: Potential for Sustainable Public Transport in Europe", September 2015

## Main Results of the Study

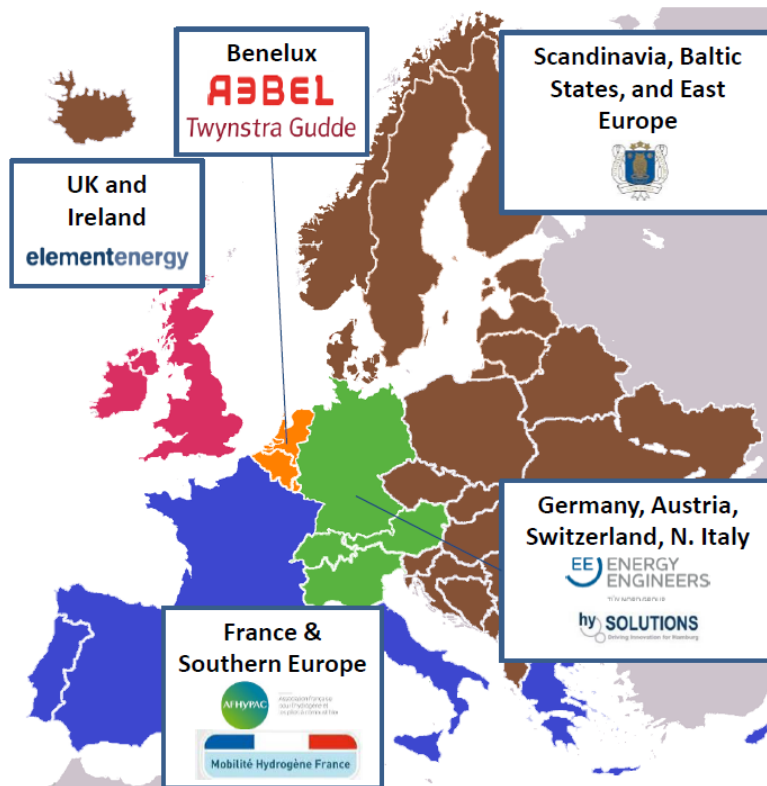
The following steps to enhance the commercialisation of fuel cell buses are suggested:

- Increase the number of fuel cell buses to 300-400 by 2020
- Continue work to reduce costs of buses and hydrogen refuelling infrastructure
- Engage with bus operators to deliver large-scale demonstration projects
- Implement an appropriate public support framework

[www.fch.europa.eu/sites/default/files/150909\\_FINAL\\_Bus\\_Study\\_Report\\_OUT\\_0.PDF](http://www.fch.europa.eu/sites/default/files/150909_FINAL_Bus_Study_Report_OUT_0.PDF)



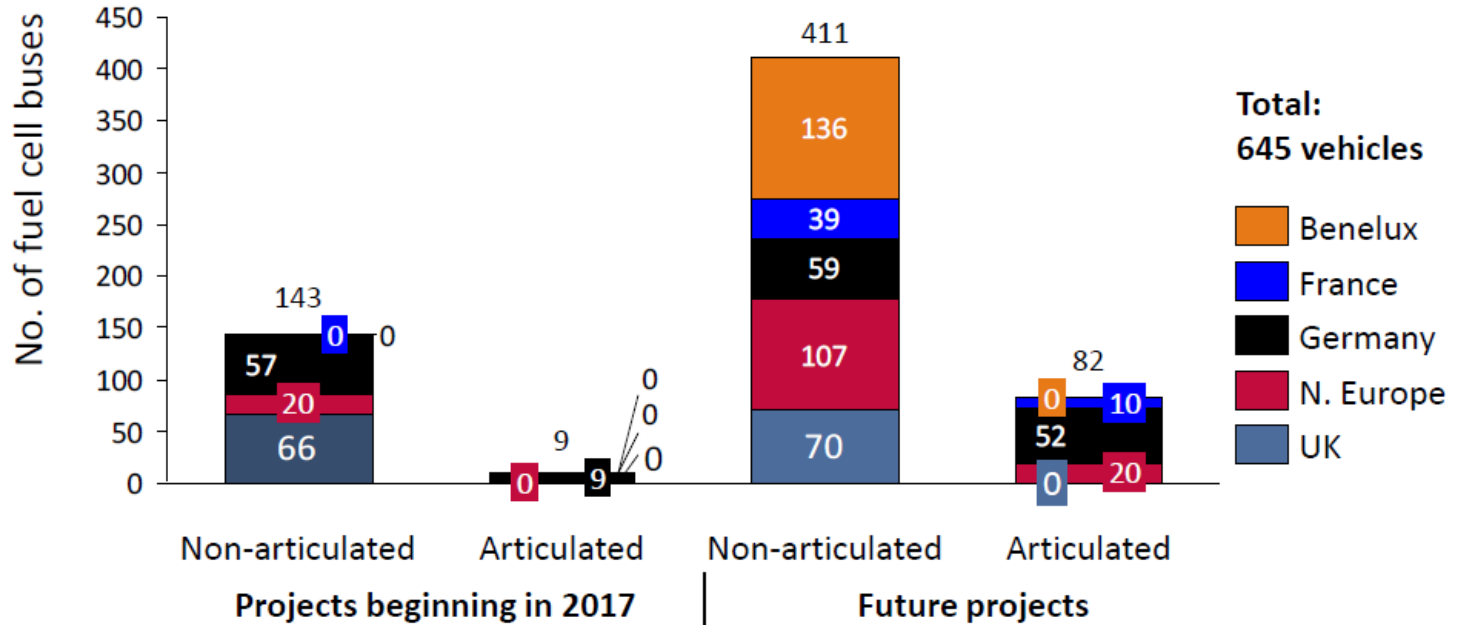
## Step 1: Installation of Fuel Cell Bus Procurement Clusters



### Members of German Cluster:

- Hochbahn Hamburg
- Vi Potsdam
- SW Münster
- Wuppertaler Stadtwerke
- VRR
- RVK Hürth
- Rheinbahn Düsseldorf
- moBiel Bielefeld
- EVAG Essen
- MVG Mainz
- ESWE Wiesbaden
- Trafiq Frankfurt
- Stuttgarter SB
- Bozen, Bruneck, Rovereto (Italy)
- Innsbruck (Austria)

## Potential Demand for fuel cell buses by cluster and bus type



## Step 2: Engineering of HRS designed for buses

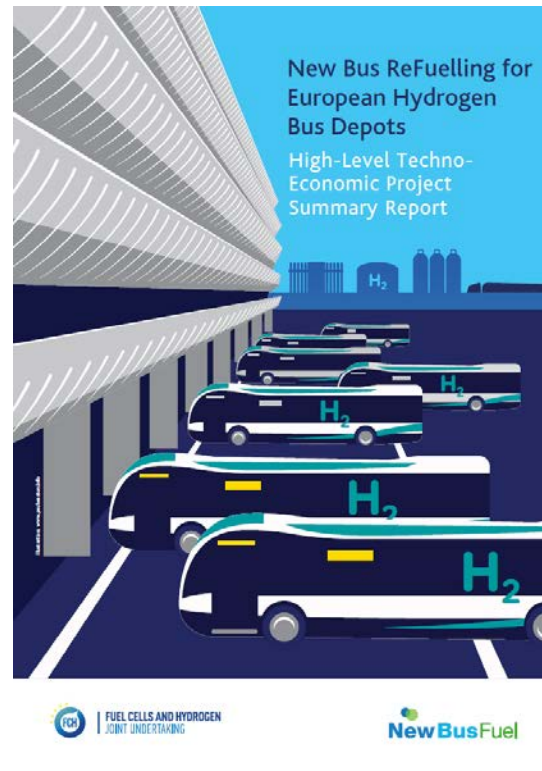


FUEL CELLS AND HYDROGEN  
JOINT UNDERTAKING

### “New Bus ReFuelling for European Hydrogen Bus Depots”

- Kickoff 1. July 2015, duration 18 months
- 13 case studies for bus depot-HRS, Supply for > 100 buses
- Concepts: Electrolysis, Reforming, Trailer transport (G/L), Pipeline
- Electricity from renewable sources
- Biogas for Reforming

[newbusfuel.eu/publications/](http://newbusfuel.eu/publications/)



## Step 3: Building of Hydrogen Stations for Buses

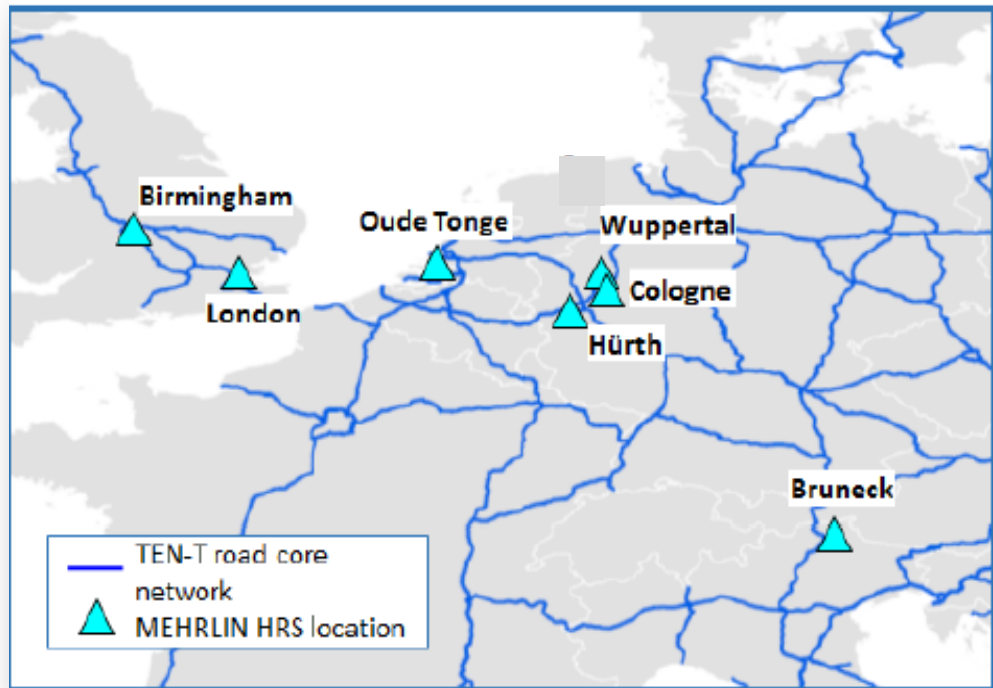
### Project MEHRLIN

Models for Economic  
Hydrogen Refueling  
Infrastructure

- Economic viability and reliability of large HRS
- Project launch end 2016, duration 48 month



CEF: Connecting Europe Facility  
DG MOVE  
Grant No. 2015-EU-TM-0316-S



## Step 3: Building of Hydrogen Stations for Buses

### Project MEHRLIN

Station location	Source of hydrogen	Notes
<b>Bruneck, Italy</b>	260kg/day on-site electrolysis using green electricity	Part of new site offering multiple alternative fuels
<b>Wermelskirchen, Cologne, Germany</b>	By-product delivered from nearby chemical plant	New site developed for inter-urban buses
<b>Hürth, Cologne, Germany</b>	By-product delivered from nearby chemical plant	Upgrade of existing public station
<b>Wuppertal, Germany</b>	320kg/day on-site electrolysis using green electricity	Electrolysis linked to electricity generation from waste
<b>South Rotterdam, the Netherlands</b>	480kg/day on-site electrolysis using green electricity	Electrolysis linked to abundant regional wind resource
<b>Birmingham, UK</b>	680kg/day on-site electrolysis using green electricity	Will use green electricity and provide grid balancing
<b>London, UK</b>	Delivered liquid hydrogen	Designed for easy upgrade to high capacity fuelling (tonnes/day)

## Step 4: Joint Procurement of Buses

### Project JIVE: Joint Initiative for Hydrogen Vehicles across Europe

#### Objectives

- Deploy 139 FC buses across nine cities
- Achieve 30% cost reduction versus state of the art
- Operate 50% of the vehicles for at least 36 months
- Deploy the largest capacity HRS in Europe
- Achieve near 100% reliability of HRS
- Demonstrate technological readiness of FC buses and HRS
- Encourage further uptake

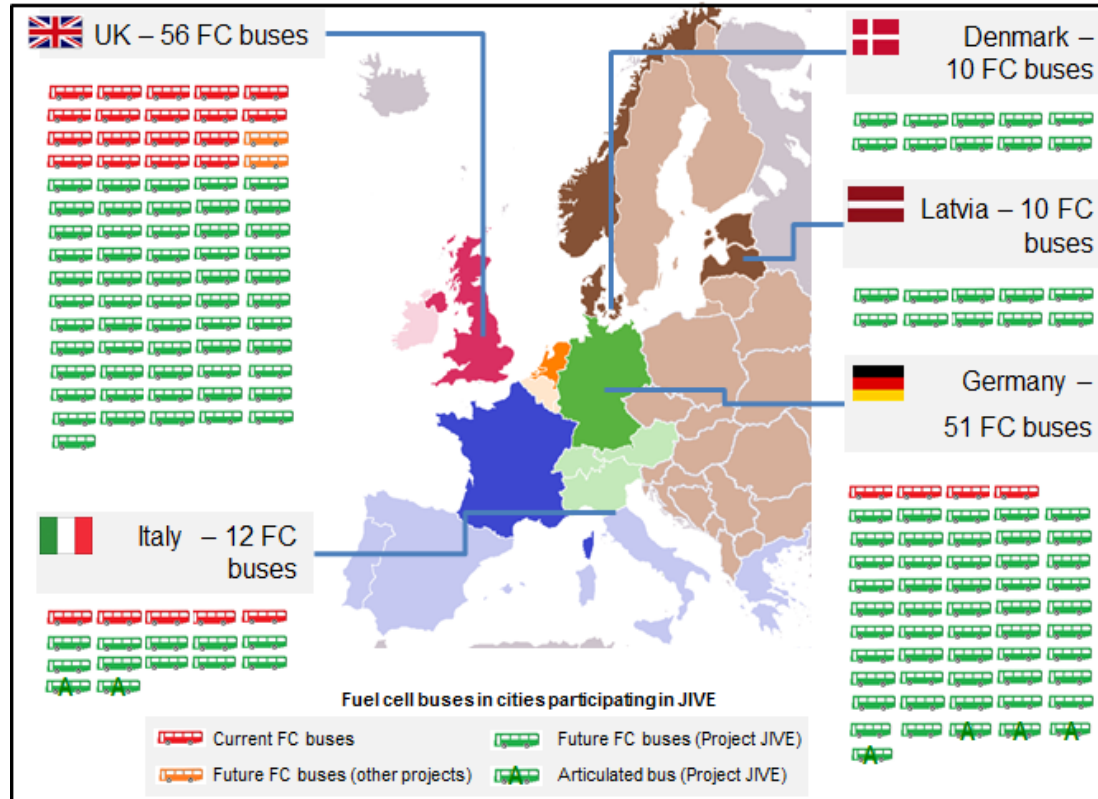


**Duration 2017-2022**

**Funding 32 Mio. € from the FCH 2 JU under grant agreement No 735582**



## Step 4: Joint Procurement of Buses



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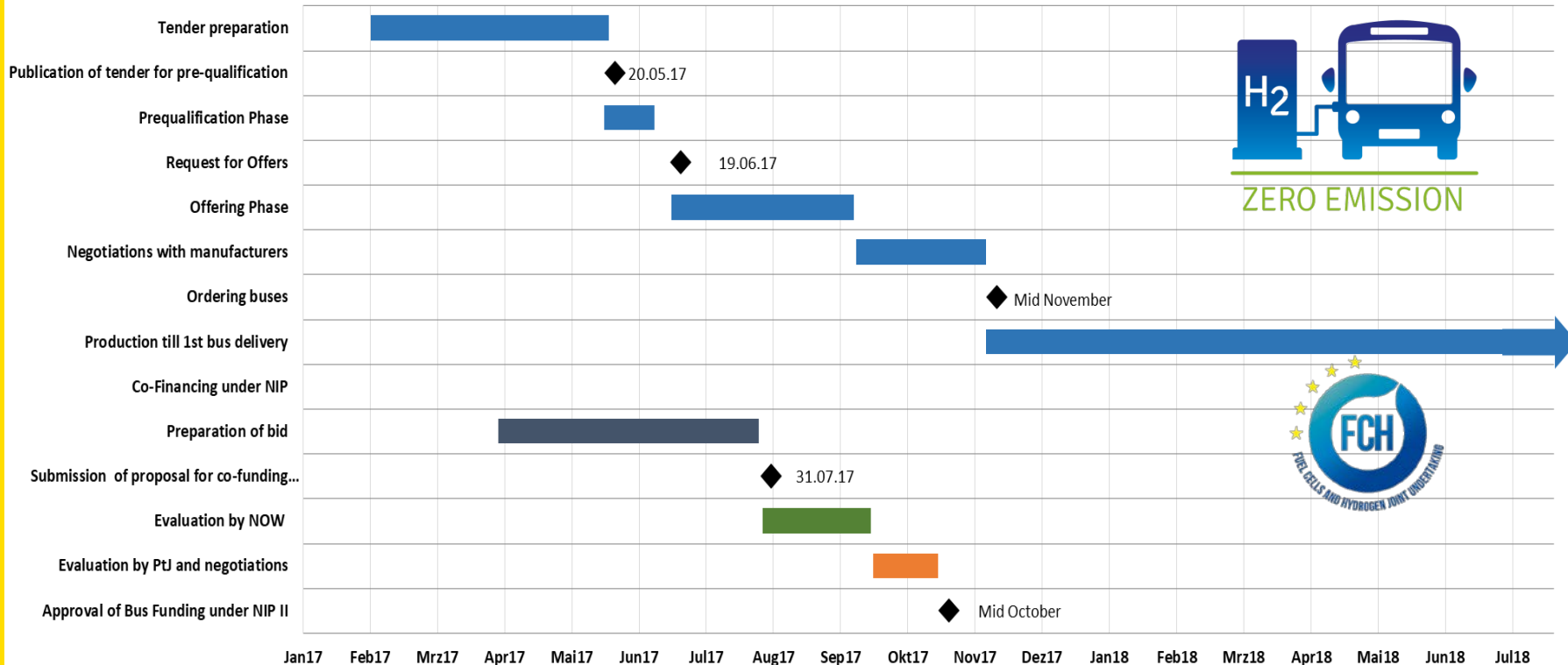
### Funding Scheme Example for Procurement in Germany

Maximum Purchase Price 12 m bus (according to call):	650.000
Funding FCH JU, ca.	-200.000
Funding Germany under NIP II (40 % of cost gap between FC and Diesel bus (250.000 €))	<u>-160.000</u>
Remaining:	<u>290.000</u>



# Step 4: Joint Procurement of Buses

Schedule JIVE Bus Procurement German Bus Operators

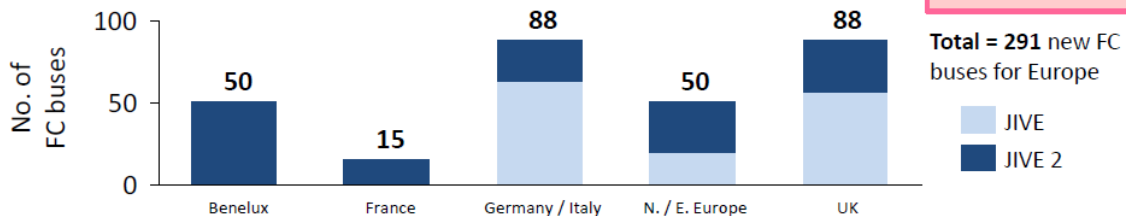
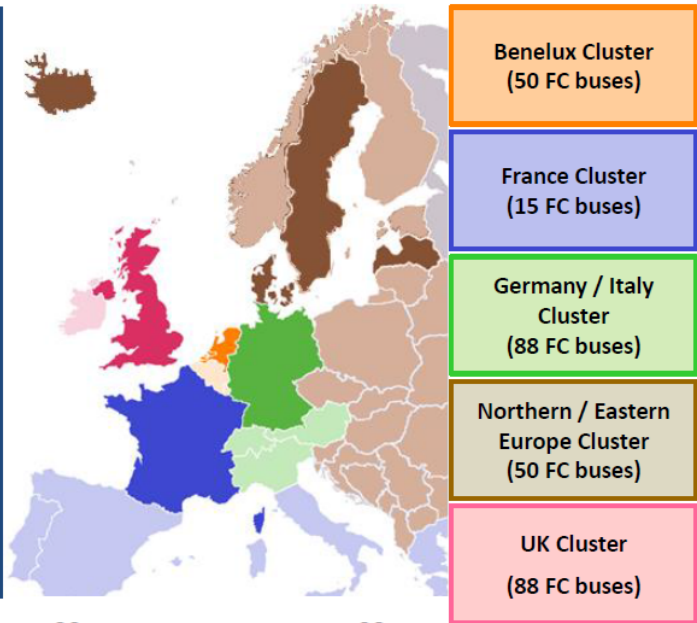


# The Next Step

## JIVE 2: Joint Initiative for hydrogen Vehicles across Europe Phase 2

**Objectives**

- Deploy 152 FC buses across 14 cities
- Achieve a maximum price of €625k for a standard fuel cell bus
- Operate buses for at least three years / 150,000 km
- Validate large scale fleets in operation
- Enable new entrants to trial the technology
- Demonstrate routes to low cost renewable H<sub>2</sub>
- Stimulate further large scale uptake



## Summary

- Fuel cell buses offer zero emission public transport with the flexibility and usability of a diesel bus
- The TCO of FC buses can come down to a premium of 10 % compared to diesel
- A multi step approach has been started to commercialize FC buses
  - Installation of procurement clusters
  - Engineering of hydrogen stations for buses
  - Installation of bus filling stations
  - Large scale procurement of FC buses
- First responses to tenders show that target prices can be reached