CiVITAS FORUM 2017

CIVITAS ANNUAL CONFERENCE | 27-29 SEPTEMBER | TORRES VEDRAS

JIVE – fuel cell buses, a zero emission solution

Sabrine Skiker, Communications and EU Policy Manager

ZERO EMISSION

JIVE and MEHRLIN projects

Section B3 - Success factors for the deployment of clean fuels and vehicles in cities

The JIVE project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 735582. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N.HERGY. The MEHRLIN project is co-financed by the European Union's Connecting Europe Facility.

Table of contents

- Who we are
- Introduction to fuel cell buses
- FCB projects results
- Success factors
- JIVE
- Commercialisation strategy

Hydrogen Europe Membership >185 Companies, Research institutes and Associations

ZERO EMISSION

Aim : Making hydrogen and fuel cells an everyday reality in Europe

Specifically on buses: lead of the dissemination activities of JIVE

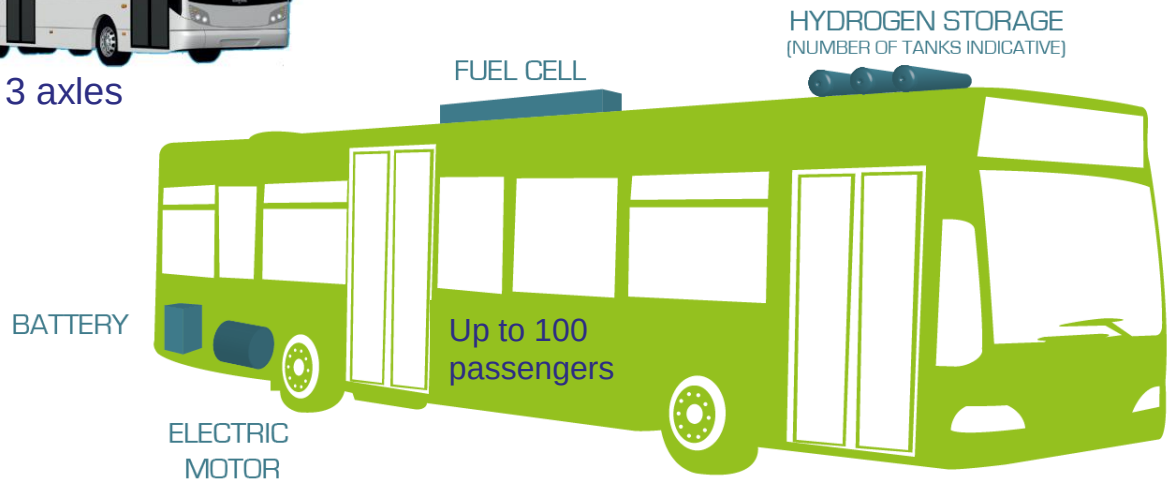
Cities' common challenges & political solutions

- Cities across Europe and beyond are facing common challenges:
  - **Increasing urbanisation & congestion** – growing demand for transport services
  - **Environmental challenges** – air quality, GHG emissions
  - **Economic constraints** –affordable, reliable, high quality services with limited budgets
- Political answers: cities and countries plans to phase out diesel (France, Netherlands, UK) and go for zero emission solutions (e.g. Olso, Hamburg, Paris)

- Electrification as the only long term viable option for delivering zero emission buses, with two principal options:
  1) Battery electric buses
  2) Fuel cell electric buses

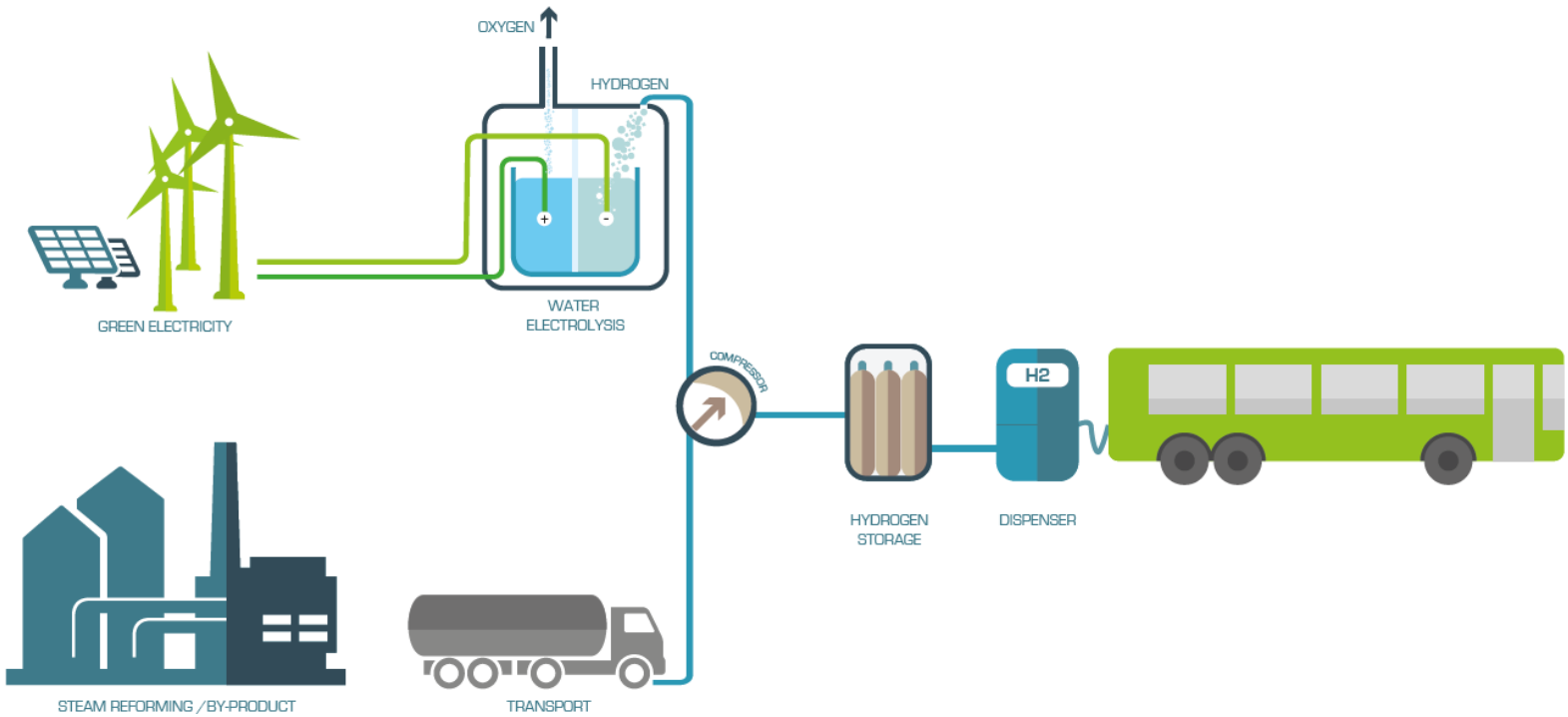
A fuel cell bus : an electric bus

2 or 3 axles



- Hydrogen = the fuel used
- Fuel cell: “transform” hydrogen in electrical energy
- Electric motor: converting electrical energy to mechanical energy
- Battery: balancing peaks in demand and storing regenerated braking energy

Hydrogen production/ Refuelling Station - basics



- Hydrogen main sources: SMR/green hydrogen/by product
- Hydrogen as a fuel, as energy carrier, as long term /seasonal storage (e.g. of excess renewable electricity)
- Bus depot adaptation
- Specific training required

Why choose fuel cell buses?

High daily range

350+ km without refuelling

Operational flexibility

…no need for new street infrastructure, rapid refuelling (<10 min)

Zero tailpipe emissions

Only water emitted and CO_2 emissions savings – linked to hydrogen production source

Comfort for passengers and drivers

…due to reduced noise levels and smooth driving experience

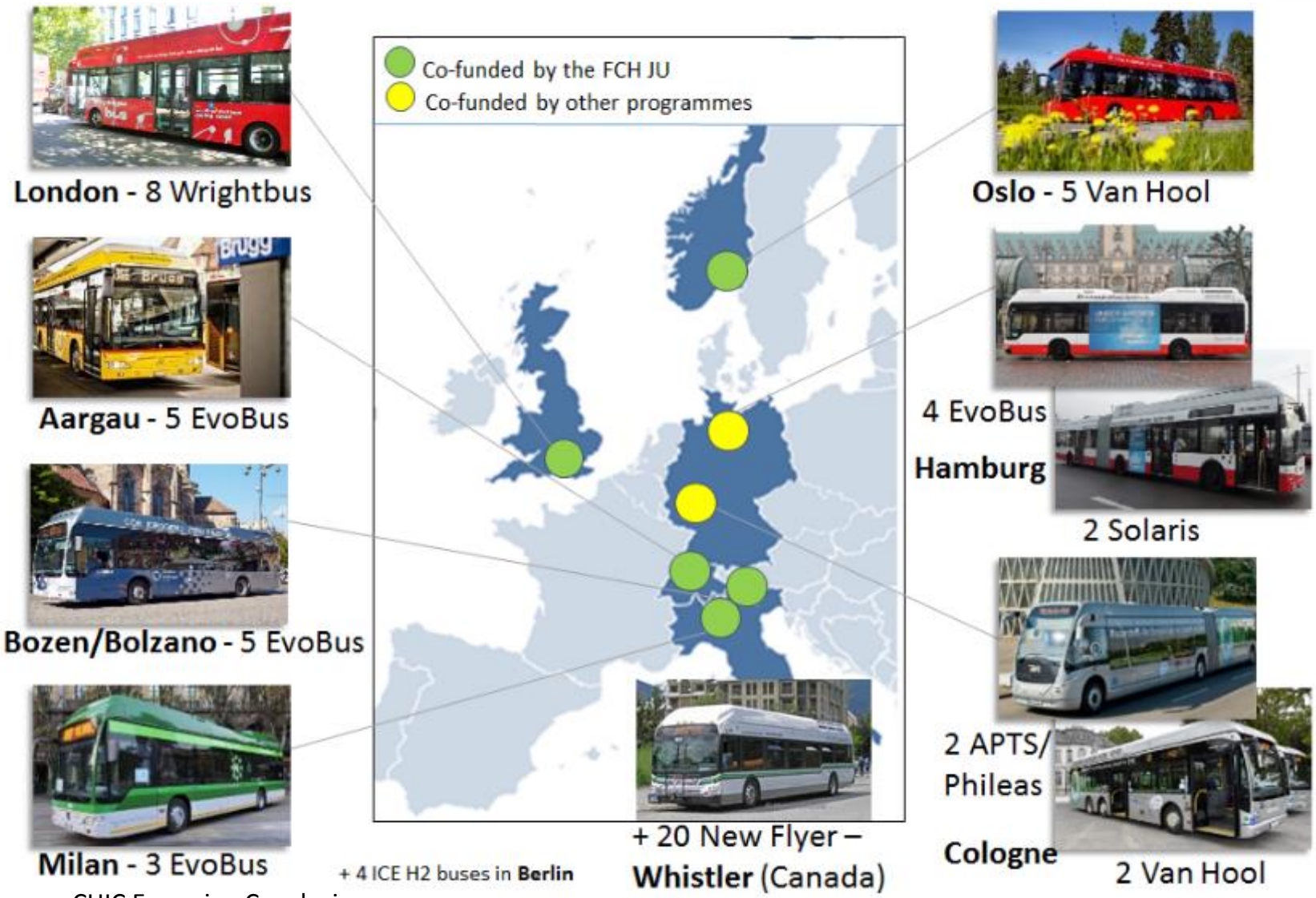
Collaboration

A European network of frontrunners in place willing to share their expertise

A concrete answer to ambitious **policy targets** set for **transport decarbonisation**

Source: CHIC Emerging Conclusions

CHIC delivered 56 fuel cell buses in eight cities from six different OEMs (2010-2016)



Source: CHIC Emerging Conclusions

CHIC conclusions

Fuel cell buses can offer:

✓ **Operational flexibility** (comparable to diesel):

→ Experience with >9 million kms driven

✓ **Zero local emissions**

✓ **Reduced CO_2 emissions,** with a pathway to zero emission

→**-** 85% reduction compared to diesel buses along the bus life cycle when hydrogen fuel is produced from renewable energy sources

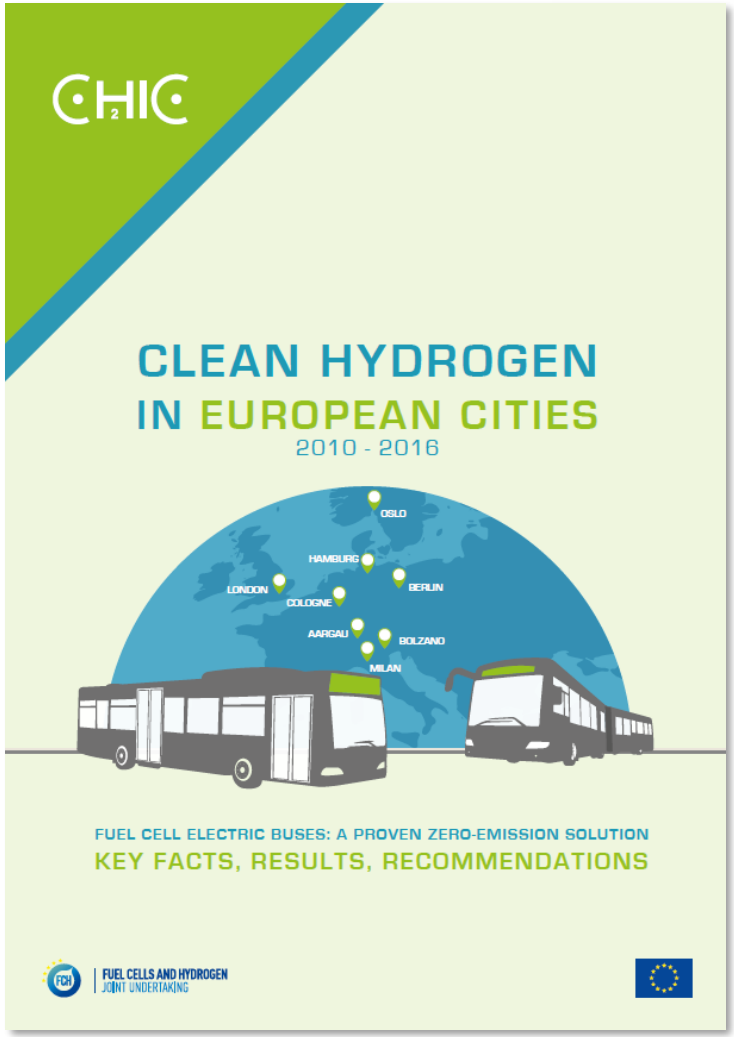
→ 6,800 tonnes of CO2 equivalent saved

→ **>** 4.3 million litres diesel avoided

✓ **Satisfaction for end users** (drivers & passengers)

Recommendations

- **Improve bus availability,** especially at the beginning – by resolving teething technical issues & increasing scale
- **Reduce the technology costs – bus and hydrogen prices** – coordinated commercialisation process (see below)
- **Harmonise regulations** on hydrogen refuelling stations – work underway on international standards



Report available at:
http://www.fuelcellbuses.eu/public-transport-hydrogen/fuel-cell-electric-buses-proven-zero-emission-solution

Success factors – project initiation & pre-procurement

Collaboration	Plan	Regional context	Budget
Involve key delivery partners at an early stage & initiate a dialogue with the market players	Develop a detailed project plan : identify route, define technical specifications at an early stage	Put the fuel cell bus project in a larger context – eg potential hydrogen regional strategy - ex. region with renewable sources available	Get an detailed understanding of the budget – look at match funding opportunities at EU, national, regional level

Success factors – project delivery

- **People are key**: allocate sufficient resources for staff training and refreshing courses
- Introduce FC buses **smoothly**: introduction of a new technology can cause oprational stress
- **Communication/Expectations management**. Clear and regular communication with end users & finance providers is essential
- **Technical assistance** on site for the buses should be planned
- **Refuelling station** should be **located** close to the bus depot and the drivers allowed to refuel the buses

The largest fuel cell bus deployment project to date started in January 2017 for 6 years – 139 new fuel cell buses

JIVE – bus deployment

- **139 new zero emission fuel cell buses** across 5 countries

MEHRLIN – infrastructure

- **7 hydrogen refuelling stations** in 7 EU locations

Aim: advance the **commercialisation of fuel cell buses** and **boost the deployment of hydrogen as an alternative fuel** in the EU through large-scale deployment of vehicles and infrastructure

- Co-funded by a €32M from the **FCH JU** under the **EU Horizon 2020** programme

- Co-funded by €5.5M from the EU **Connecting Europe Facility**

JIVE & MEHRLIN Partners and deployment sites

1 Scottish cluster – 10 FC buses

Aberdeen City Council

Dundee City Council

2 Birmingham – 20 FC buses

Birmingham City Council

ITM Power

3 London – 26 FC buses

London Bus Services Ltd

London Bus Services Ltd

4 South Tyrol – 15 FC buses

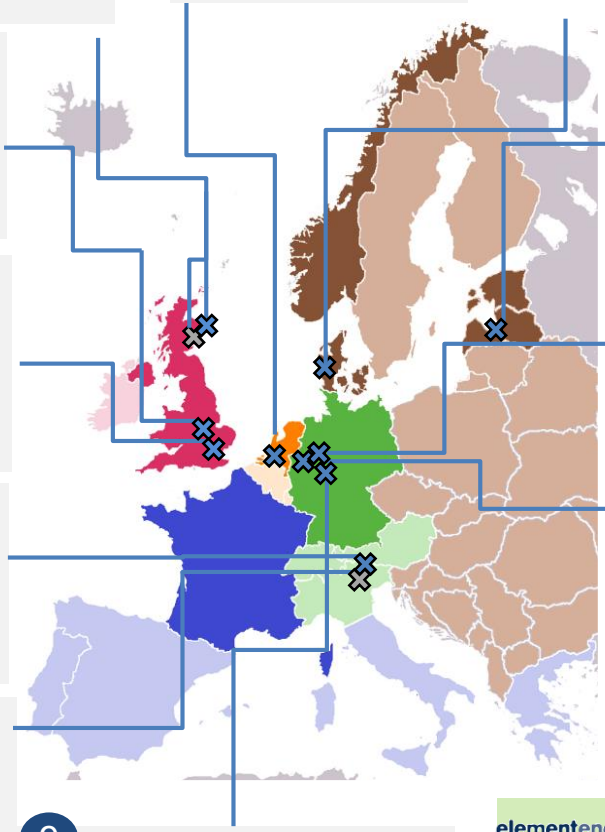
STA, IIT

10 Rovereto

Trentino Trasporti

Oude Tonge

Stedin Diensten



5 Denmark – 10 FC buses

City tbc

6 Riga – 10 FC buses

Riga Satiksme

7 Wuppertal – 10 FC buses

WSW mobil AWG

8 Köln – 30 FC buses

Regionalverkehr Köln

Regionalverkehr Köln

Stadwerke Hürth

9 Rhein-Main – 11 FC buses

VMW

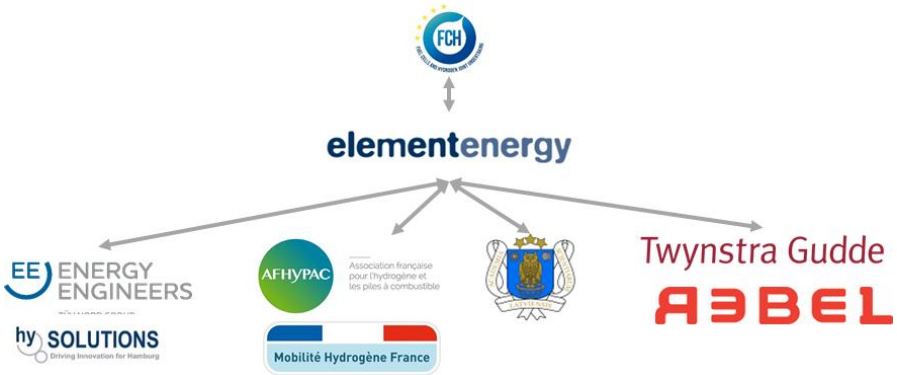
Local coordinators JIVE

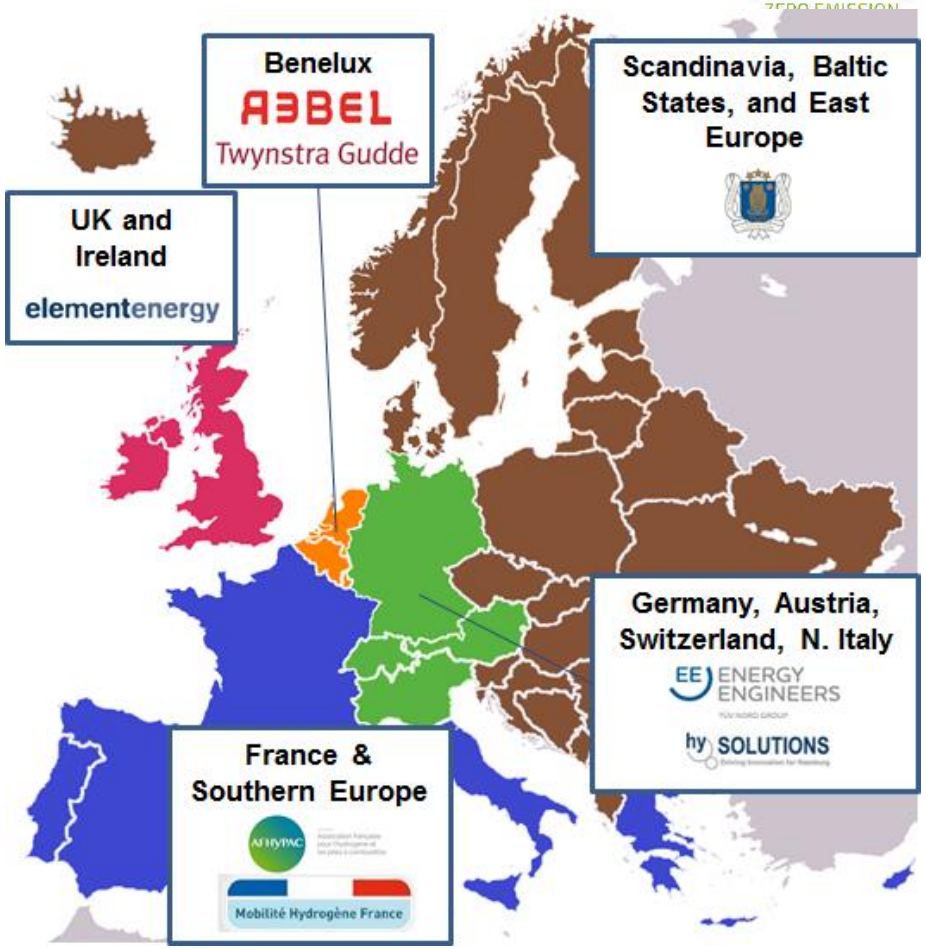
Local coordinator MERHLIN

Bus operators

Follower

Five clusters in place looking at demand aggregation, match funding strategies

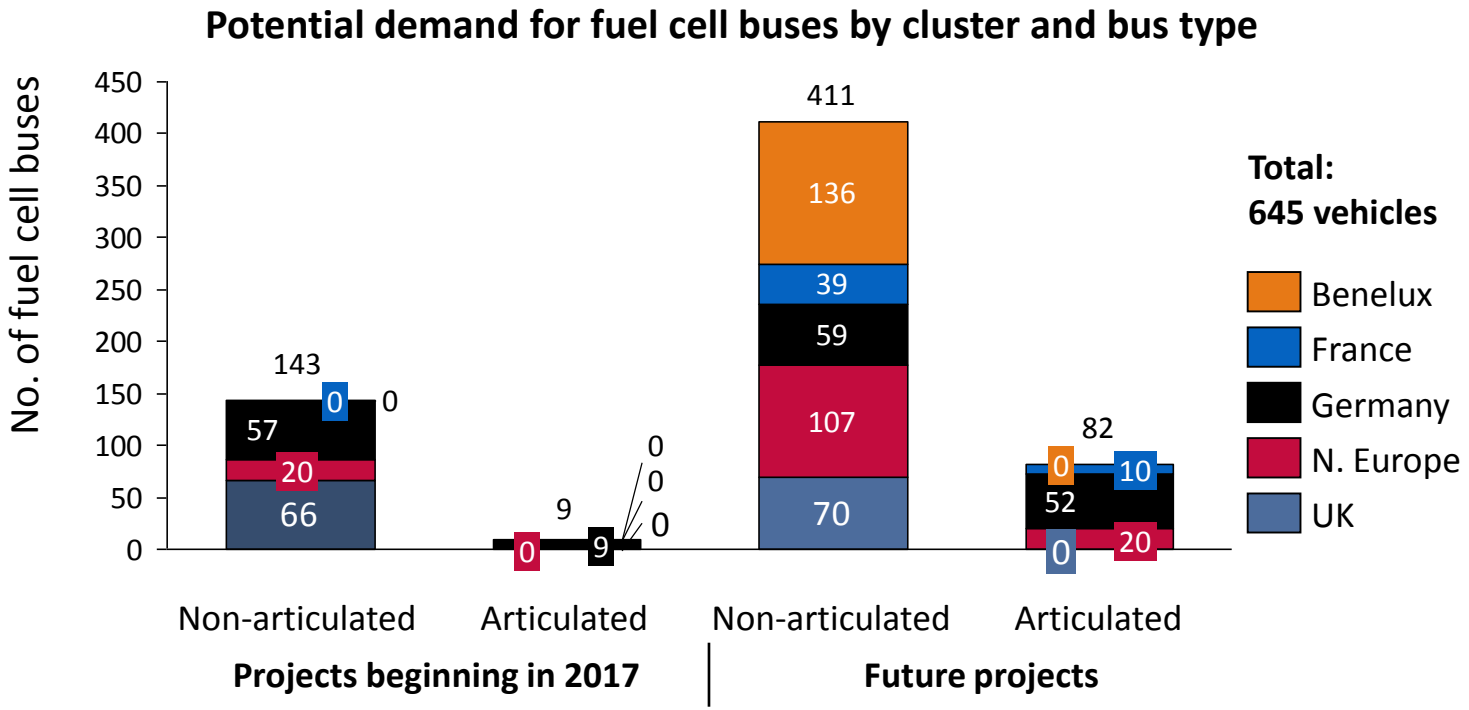




Strategies for joint procurement of fuel cell buses (July 2016)

http://www.fuelcellbuses.eu/public-transport-hydrogen/strategies-joint-procurement-fuel-cell-electric-buses-0

Working with city representatives, the cluster coordinators identified demand for >600 fuel cell buses across Europe

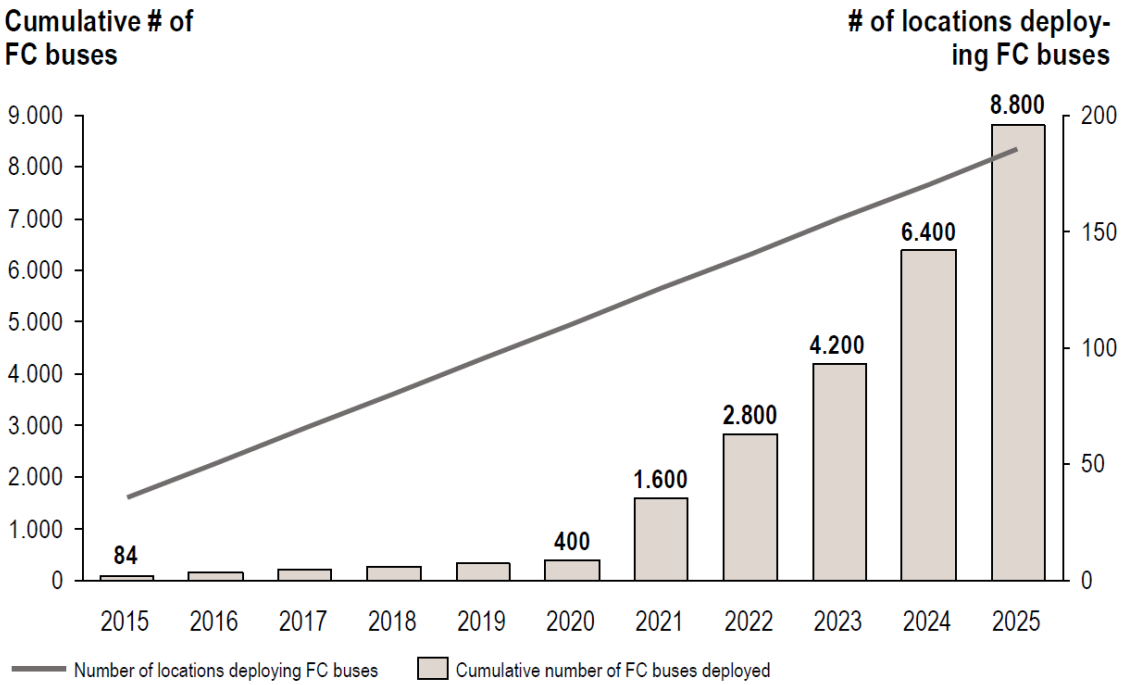


Note that these are provisional estimates based on the work of the cluster coordinators to date. No firm commitment has been made by the cities. While the cluster coordinators have sought to provide realistic and relatively conservative deployment numbers, in practice these figures may fall as more detailed local feasibility work is undertaken.

Source: *Strategies for joint procurement of fuel cell buses*, Element Energy et al. for the FCH JU, Figure 9, p.30 (July 2016).
http://www.fuelcellbuses.eu/public-transport-hydrogen/strategies-joint-procurement-fuel-cell-electric-buses-0

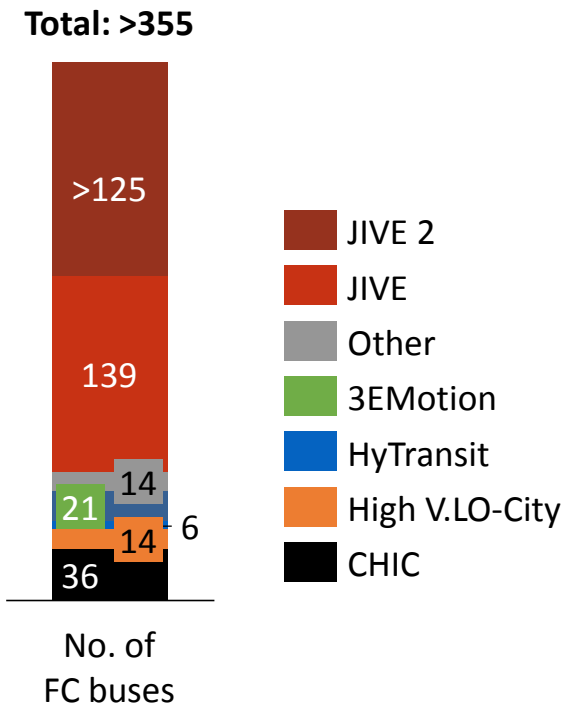
In progress and planned deployments are expected to deliver 400 fuel cell buses in Europe by 2020

Ramp-up scenario for FC buses in Europe



Source: *Fuel Cell Electric Buses – Potential for Sustainable Public Transport in Europe*, Figure 29, p.48, Roland Berger for the FCH JU (2015).

Number of fuel cell buses in Europe deployed / planned by project



Existing / planned projects will deliver 350–400 FC buses by the early 2020s – large scale joint procurements will be required to unlock further cost reductions and widespread deployments

Source: Element Energy

Thank you for your attention

Project coordination
Element Energy Limited

Project dissemination
Hydrogen Europe

Sabrine Skiker
Communications and EU Policy Manager
s.skiker@hydrogeneurope.eu

www.fuelcellbuses.eu

ZERO EMISSION

@fuelcellbus

Back-up slides

Fuel Cells & Hydrogen Joint Undertaking 2

ZERO EMISSION

Hydrogen Europe

Industry Grouping
Hydrogen Europe

European Union
represented by the European Commission

Hydrogen Europe Research

Research Grouping
Hydrogen Europe research

A portfolio of clean, efficient and competitive solutions based on fuel cells and hydrogen technologies **in energy and transport**

Where are fuel cell buses in Europe today & tomorrow

EU-funded FCB projects

CHIC (project over in 2016/buses still driving)

- ✓ Bolzano, IT– 5 FC buses (2013)
- ✓ London, UK – 8 FC buses (2011)
- ✓ Milan, IT – 3 FC buses (2013)
- ✓ Oslo, NO – 5 FC buses (2013)
- ✓ Cologne, DE* – 2 FC buses (2014)
- ✓ Hamburg, DE* – 6 FC buses (2011/2015)

High V.LO-City

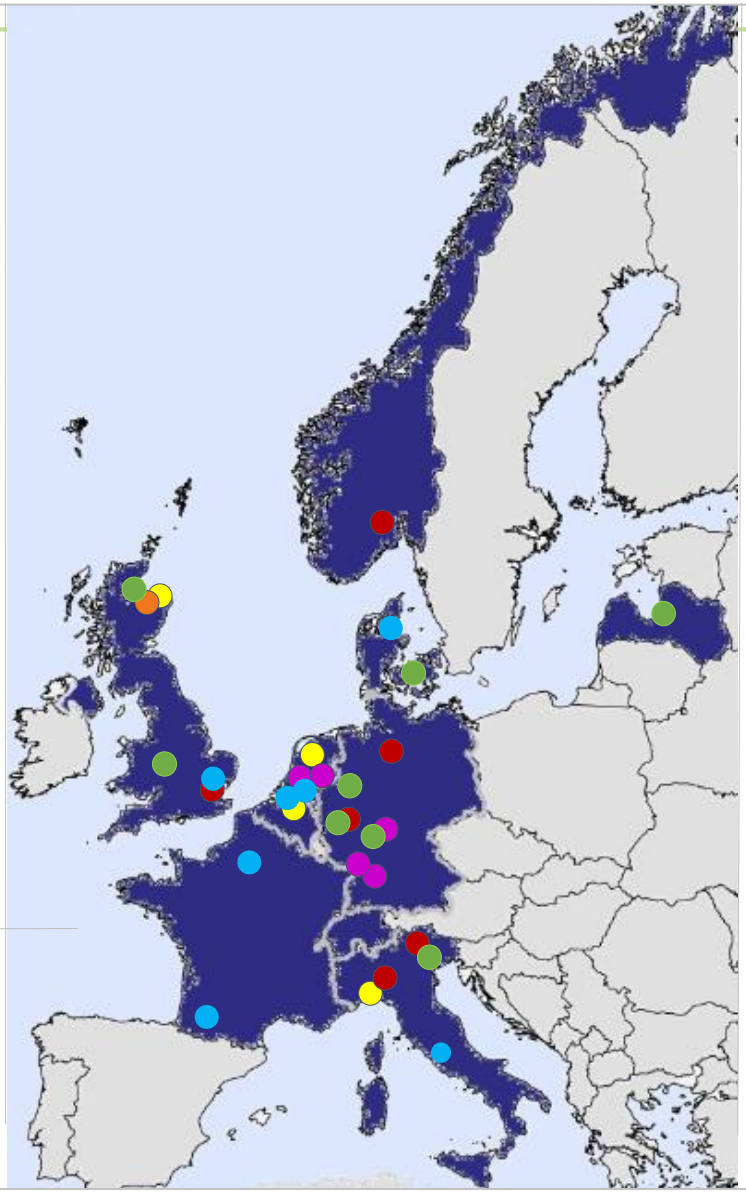
- ✓ Antwerp, BE – 5 FC buses (2014)
- ✓ Aberdeen, UK – 4 FC buses (2015)
- ✓ Groningen, NL – 2 FC buses (2016)
- ✓ San Remo, IT – 3 FC buses (2017)

HyTransit

- ✓ Aberdeen, UK – 6 FC buses (2015)

Legend

- Countries with (upcoming) FCB
- ✓ In operation
- ✓ Planned operation
- (2015) Operation start/planned start
- * Co-financed by regional/national funding sources



EU-funded FCB projects

3Emotion

- ✓ Aalborg, DK – 3 FC buses (2018)
- ✓ London, UK – 2 FC buses (2017)
- ✓ Pau, FR – 8 FC buses (2019)
- ✓ Rome, IT – 5 FC buses (2018)
- ✓ South Rotterdam, NL – 2 FC buses (2017)
- ✓ South Holland, NL – 4 FC buses (2018)
- ✓ Versailles, FR – 2 FC buses (2018)

JIVE

- ✓ Aberdeeen, UK – 10 FC buses
- ✓ Birmingham – 20 FC buses
- ✓ Bozen, IT – 12 FC buses
- ✓ Cologne region, DE – 30 FC buses
- ✓ London, UK – 26 FC buses
- ✓ Rhein-Main region, DE – 11 FC buses
- ✓ Riga, LV – 10 FC buses
- ✓ Slagelse, DK – 10 buses
- ✓ Wuppertal, DE – 10 buses

Current national/regional-funded fuel cell bus projects

- ✓ Karlsruhe, DE * – 2 FC buses (2013)
- ✓ Stuttgart, DE * – 4 FC buses (2014)
- ✓ Frankfurt, DE * - 4 FC bus (2017)
- ✓ Arnhem, NL* – 1 FC bus (2017)
- ✓ North Brabant, NL* – 2 FC buses (2017)

Last update: Sept 2017

The NewBusFuel project examined options for large-scale hydrogen refuelling at bus depots

NewBusFuel

ZERO EMISSION

1 Aberdeen
- Linde
- Aberdeen City Council

2 Birmingham
- ITM Power
- Birmingham City Council

7 London
- Air Products
- London Bus Services Limited

4 De Lijn
- Linde
- De Lijn

13 Wuppertal
- Hydrogenics
- Wuppertaler Stadtwerke

8 Madrid
- Abengoa Hidrógeno
- Empresa Municipal de Transportes de Madrid

9 Oslo/Akershus
- HYOP
- Akershus City Council
- Kunnskapsbyen Lillestrom Forening

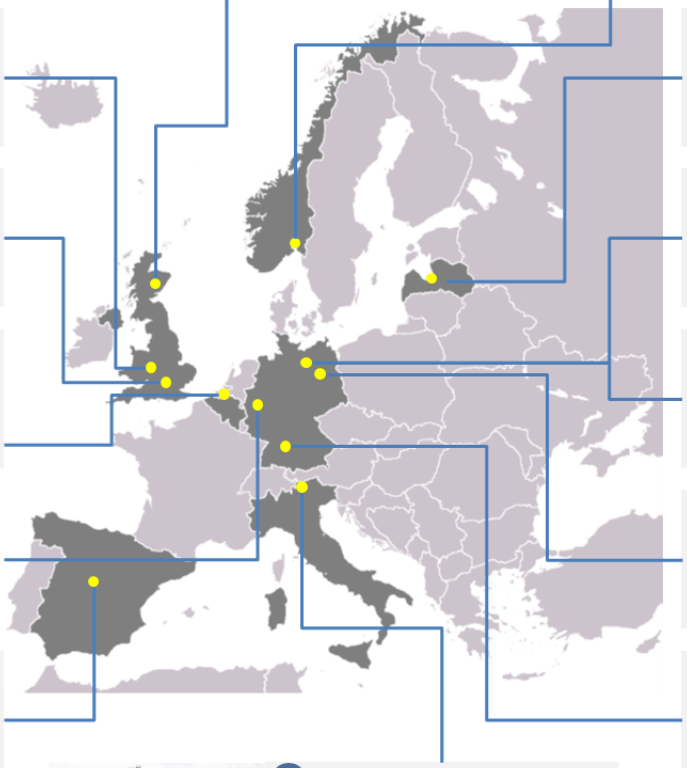
11 Riga
- Industry role to be tendered
- Riga Satiksme

5 Hamburg 1
- Vattenfall Innovation
- Hamburger Hochbahn
- Siemens

6 Hamburg 2
- Air Products
- Hamburger Hochbahn

10 Potsdam
- McPhy Energy
- ViP Potsdam
- H2 Logic

12 Stuttgart
- Siemens
- Stuttgarter Strassenbahnen



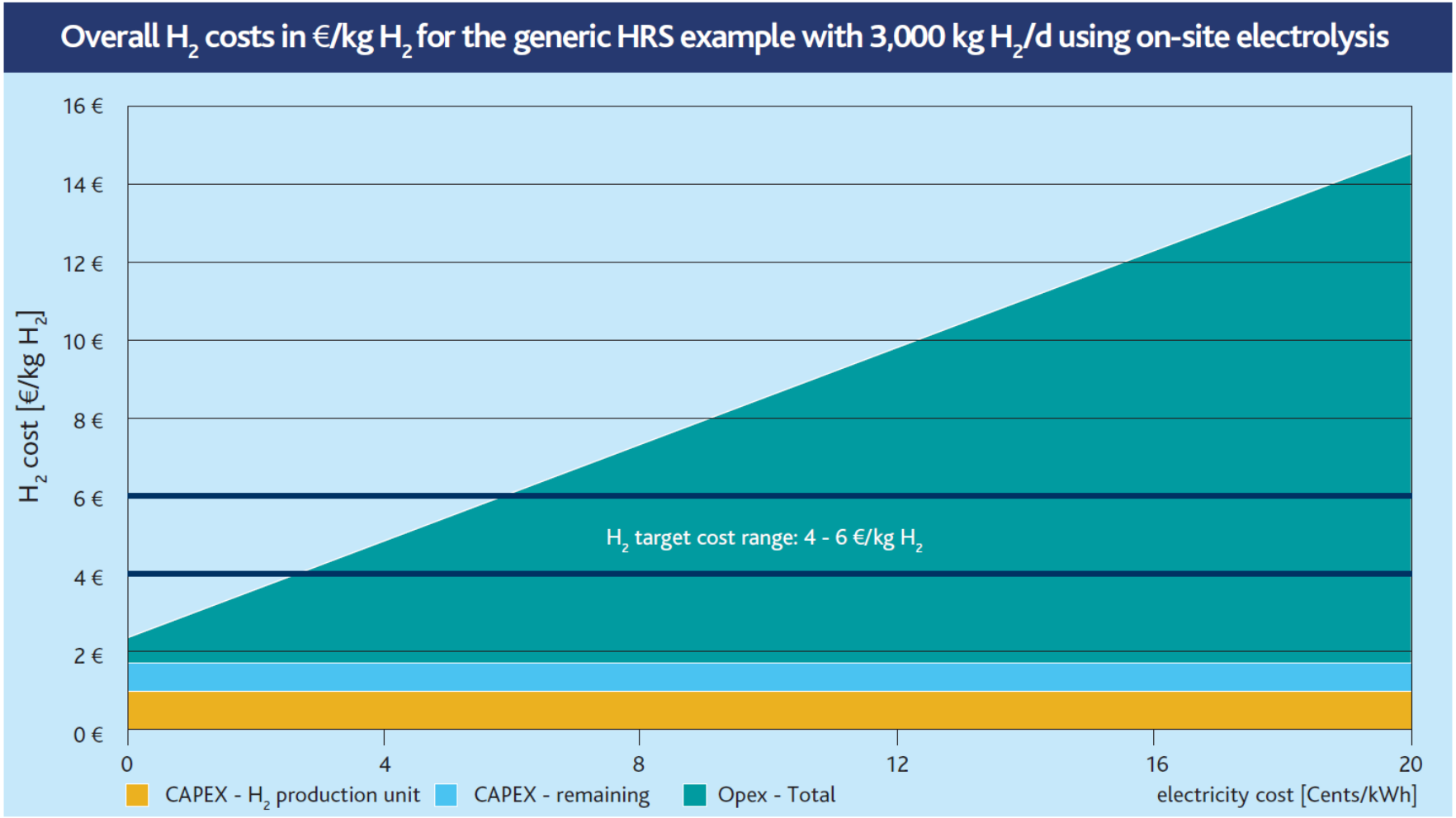
3 Bolzano
- Ingenieurbüro Bergmeister
- Institut für Innovative Technologien Bozen Konsortial
- Siemens, Linde

Industrial lead
Operator lead
Other industrial

Inter-study partners: Element Energy, thinkstep

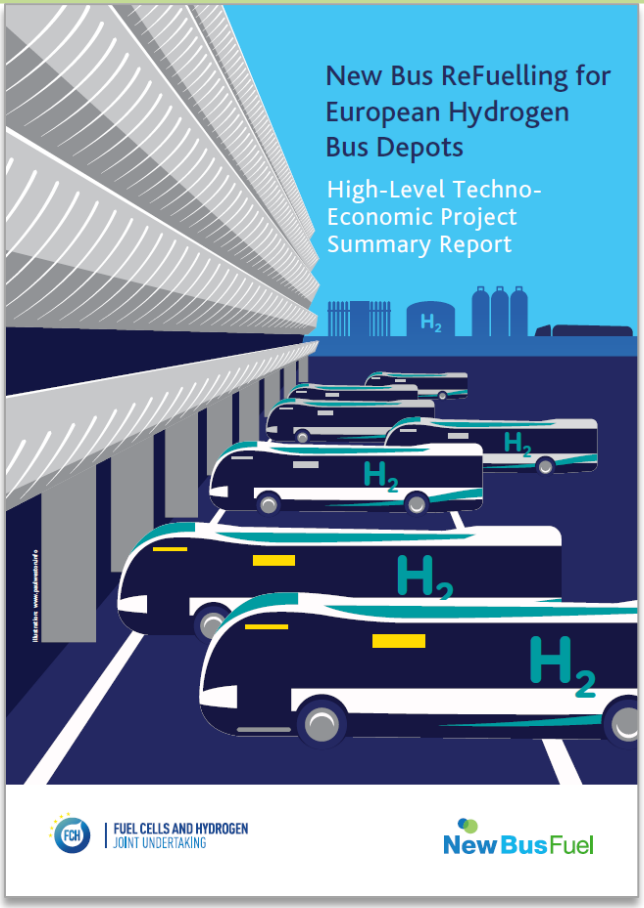
Source: NewBusFuel project

Accessing low cost (renewable) energy supplies will be key to generating cost-effective hydrogen



Source: NewBusFuel project

The main NewBusFuel project results are available as two reports: a techno-economic summary and a guidance document



The two main project reports are intended to assist procurement activities for bus operators with no prior experience of hydrogen refuelling technologies

Reports available at:
http://newbusfuel.eu/publications/